DOCUMENT RESUME

ED 052 053 SE 012 040

AUTHOR	Mitchell, Lawrence L.; And Others
TITLE	Project MOD Student. The Development of a System of Instruction for Teaching Mathematics to the Occupational and Development Student.
INSTITUTION	Blue Mountain Community Coll., Pendleton, Oreg.
PUB DATE	Jun 70
NOTE	108p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$6.58
DESCRIPTORS	Algebra, *College Mathematics, Diagnostic Teaching, *Independent Study, *Instruction, *Mathematics, Programed Materials, *Student Placement, Study Centers, Teaching Procedures

ABSTRACT

The report presents a summary of a mathematics project involving a system of individualized, laboratory and classroom instruction techniques for occupational and developmental college students. Continual diagnosis of student learning difficulties, flexible prescriptions of activities, and continual evaluation of student progress are incorporated in the project. Placement and evaluation tests, course descriptions, and descriptions of study center materials are included. Test data from students involved in the program during 1970-71 is analyzed. General results of the project include: (1) development of diagnostic measurement devices; (2) development of effective remedial mathematics instructional procedures; (3) development of instructional materials; and (4) enabling more students to succeed in credit courses in mathematics. (JG)

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PROJECT MOD STUDENT

THE DEVELOPMENT OF A SYSTEM OF INSTRUCTION

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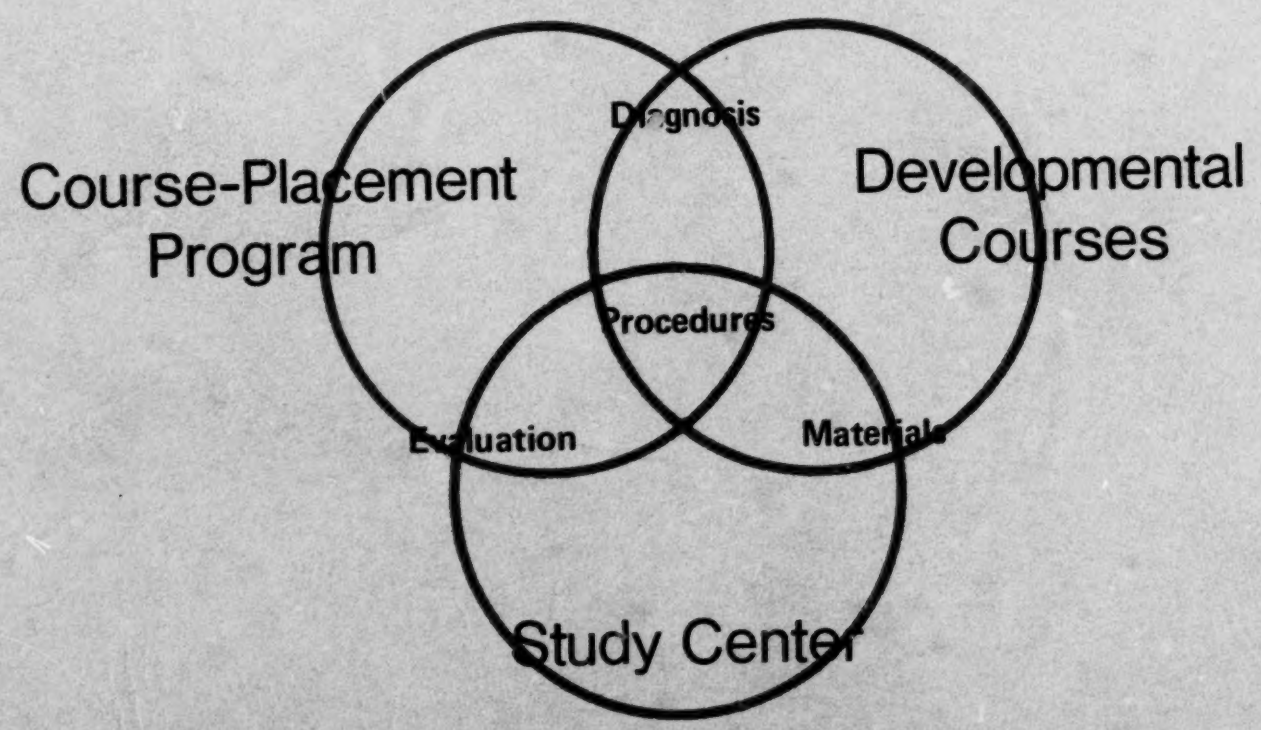

BMCC MATHEMATICS PROJECT
BLUE MOUNTAIN COMMUNITY COLLEGE
PENDLETON, OREGON 97801

JUNE, 1970

PROJECT ORIGINALLY FUNDED BY A GRANT FROM
THE OREGON LEGISLATURE THROUGH THE EDUCATIONAL COORDINATING COUNCIL

SE 012 040

ED052053

THE DEVELOPMENT

OF

A SYSTEM OF INSTRUCTION

FOR TEACHING

MATHEMATICS TO THE OCCUPATIONAL AND DEVELOPMENT STUDENT

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ABSTRACT

This report summarizes the development of a system of mathematics instruction for occupational and developmental students. The system has been designed to enable more students to succeed in credit courses in mathematics and to develop the appropriate arithmetic base for their career programs. The intent of the system is to maximize the opportunity for interactions between the teacher and individual students. It is a departure from conventional instruction in terms of both the content taught and the method used. An effort has been made to incorporate into it the following features: a continual diagnosis of each student's learning difficulties, flexible prescriptions of learning activities (self-study, dialogue and small group study, full class interaction) best suited to each student's skills and knowledge, and a continual evaluation of each student's progress. The system is based on a carefully sequenced and detailed set of objectives. The diagnostic instruments and teaching materials and methods have been correlated to these objectives. The major components of the system are a Course-Placement Program, the Developmental courses offered at Blue Mountain Community College, and the Study Center. The Course-Placement Program helps place students in the appropriate mathematics course. The Developmental Courses provide opportunities for the students to acquire enough mathematical literacy to succeed in credit courses in mathematics and to use mathematics in their occupational studies. The management of many features of these courses from the Study Center gives the system a flexibility that is virtually impossible under any other type of management. This flexibility makes it possible to tailor the courses to each student's individual goals and needs.

Though the system is neither completed nor perfect, the specific goals of the project have been accomplished. For the mathematical community, the system offers an efficient and economical method of instruction for occupational and developmental students.

THE PROJECT TEAM

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ACKNOWLEDGMENTS

The Oregon Legislature through the Educational Coordinating Council made the project possible by a grant in 1970.

Leon E. Severin, Vincent Ast, and Allan Insko have worked as teachers on the project and have offered many constructive criticisms and new ideas.

Marilyn Wright aided in the implementation of the Study Center activities as she served as a typist, secretary, tutor, teaching assistant, and coordinator.

Clara Wassom, Sally Kamm, and Kim Traver were student aides who helped prepare and use the project materials.

Helen Rosenberg typed many of the learning materials and the project reports.

Georgia Mitchelldid a superb job of typing and editing and provided encouragement and understanding throughout the project.

Patricia Harris, Director of the Study Center, has totally supported the efforts in the Study Center.

Ellsworth E. Mayer, Dean of Liberal Arts and Sciences, was instrumental in obtaining the original grant and supported the efforts of the project staff.

Wallace W. McCrae, President; Robert E. Hawk, Dean of Applied Sciences; Mary L. Bates, Head Librarian; Robin R. Woodroofe, Business Manager; Brill Lee, Audio-Visual Director; and the Counseling Center personnel aided in thecoordination of the project with the operation of the college.

Gwen Waite, Sandy McClendon, Judy Wright, and Melba Hauser provided encouragement and understanding throughout the project.

Forward—

MASTER KEY

The Provost was to meet and escort about the campus a visiting scholar. As it was a hoiday and most buildings would be locked, the President had supplied his master key which he said would open everything. All went well until it was found that the master key did not in fact turn all locks. Provost and guest were put to some inconvenience, and when later the President learned about it he must have been rather disillusioned about the potency of the master key.

How many of us who teach are trusting what we believe to be a master key for teaching? Would we not be shaken to realize that it unlocks the minds of only some of our students and with many is quite ineffective? If, for example, our master key is lecturing, we should know that, unless one as a lecturer is one in a thousand, the lecture simply does not really reach some to the students. So with other tools of teaching.

Tools of teaching do have, of course, a measure of flexibility beyond that of a metallic key. The teacher himself is more than the tool and gives it potency according to his own quality, feeble or powerful. But among teaching tools, there is truly no master key. It is the teacher who must be the master.

And he needs a whole ring of keys. He can try a lecture and then test the class to find who have learned and who have not. He may then lecture some more to enlighten the latter, though he may then be boring, even stultifying, the others. Perhaps he had better try some other procedure. Discussion, for example, will give students who have missed a point a chance to ask questions. It may give other students who got a point a chance to answer questions. The interchange can be stimulating and helpful to many, if not all. The discussion is not a master key but it is a good key. A teacher should himself be a master in guiding discussion.

There are many other keys on a master's ring. Students in discussion learn by talking. In laboratory they learn by doing. Though traditional laboratory can be "cook book," it also can be excellent. A field trip is a variant, and it can be a waste of time or something to remember, again depending largely on the teacher's skill. The writing of themes, reports, and term papers is a form of laboratory work. So also are projects. There are many more ways to teach than many of us know about, or use.

A key opening a lock is an apt symbol of the teaching-learning process. Teaching, which opens up new life to youth, stimulates growth and unfoldment of potential is the noblest human calling, linked with the divine. And the keys the teacher uses, his teaching tools, are extensions of himself. All tools are extensions of man. Man walks unaided, but with vehicles he speeds across earth, through the air, and into outer space. Man is greater than his tools, but he is greater with the tools.

So with the teacher. He is himself the master and greater than the keys, but he is greater with the keys.

DELMER M. GOODE, editor
Improving College and University Teaching
Editorial, Summer, 1970, page 167
Corvallis; Oregon State University Press

PROJECT MOD STUDENT
THE DEVELOPMENT OF A SYSTEM OF INSTRUCTION

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CHAPTER I: INTRODUCTION

The purpose of this report is to summarize the history and development of a project whose goal is to enable more students to succeed in mathematics and to develop the appropriate arithmetic base for their career programs. This chapter describes the origin of the project and the characteristics of the developmental and occupational courses and students at Blue Mountain Community College.

ORIGIN OF THE PROJECT

In recent years there has been an increased awareness among community college mathematics teachers of the need to improve the effectiveness of instruction and the appropriateness of course content in their occupational and developmental offerings. This awareness has motivated a search for innovative approaches to mathematics for occupational and developmental students. To meet the needs of these students, the Blue Mountain Community College Mathematics Department has developed an approach based upon the hypotheses that (1) the student won't learn until he sees the importance of the material and (2) instruction should be almost entirely individualized. This section presents an overview of the development of this approach.

THE NEED

About half of the students entering Oregon's community colleges need remedial work in mathematics. However, most colleges need to improve their efforts in training these students. Some specific needs to be met include:

More suitable testing devices and procedures to identify those students unlikely to succeed in regular mathematics courses without remedial attention.

New procedures in instruction to assist students to overcome deficiencies in mathematical skills.

A variety of new instructional materials available to the student and to the teacher designed to facilitate the work of both student and teacher in bringing the student to a competitive position in "regular" courses.

Centrally located, professionally staffed study centers highly conducive to learning to which students in developmental and occupational mathematics are assigned for small group and tutorial instruction under laboratory conditions and at which they may seek guidance and resources for the remediation of recognized deficiencies.

An increased recognition on the part of administrators and mathematics staffs that instructors in remedial mathematics must evidence unusual empathy and resourcefulness and that new instructors, however able and concerned, need the guidance of a carefully planned program in which attainable student goals are carefully delineated in behavioral terms if they are to work creatively with students with mathematical handicaps.

THE DEVELOPMENTAL AND OCCUPATIONAL PROGRAMS

The program of studies at Blue Mountain Community College endeavors to serve a wide range of needs and interests. The institution strives to meet these needs and interests by offering Liberal Arts and Sciences programs and Applied Science and Technologies programs.

The Liberal Arts and Sciences division serves the concerns of all lower division collegiate transfer programs. The Liberal Arts mathematics courses provide a variety of tracks to meet the needs of students with different educational goals and mathematical backgrounds and abilities. Most of the transfer programs require that the student complete some mathematics beyond the Math 101 (College Algebra) level. The student who is not prepared for Math 101 at the outset of his college career needs more time to complete this requirement. The following developmental courses are available to him: Mth 40 (Basic Mathematics), Mth 45 (Elementary Algebra), and Mth 95 (Intermediate Algebra).

The Applied Sciences and Technologies division offers preparation for technical occupations in the fields of Business, Dental Assisting, Practical Nursing, Civil Engineering Technology, General Drafting, Electronic Engineering Technology, Law Enforcement, Mechanical Technology, Technical Agriculture, Air Traffic Technology, and Broadcasting. Each program has its own course requirements and students have the opportunity to begin their mathematics programs at different levels. All of the programs require a level of achievement at least equivalent to Mth 40 (Basic Mathematics). All but the Practical Nursing and Law Enforcement programs require mathematical preparation beyond that level. In Mechanical Technology, Air Transportation Technology, General Drafting, and Technical Agriculture, the usual sequence is Mth 40 (Basic Mathematics), Mth 4.202 (Applied Algebra), and Mth 4.204 (Applied Mathematics). Business and Dental Assistant students have available Mth 40 (Basic Mathematics), and the sequence of business mathematics classes 2.252, 2.254, and 2.275. The Technical Mathematics courses for Broadcasting and Civil and Electronic Engineering Technology students have prerequisites beyond Mth 40 and Mth 45.

A comparison of the mathematics courses in both the Liberal Arts and Applied Sciences programs identifies Mth 40 (Basic Mathematics) as a critical course in the curricula. It is available to those students who, because of a weak background, are not prepared to begin transfer credit courses in mathematics. In addition it is a service course for the career programs which have a mathematics base of arithmetic. High dropout rates and low levels of achievement in this and the other developmental courses prompted the Mathematics Department to seek ways to improve these offerings. For three years (1967-1970) the department carried out a very limited pilot project within the regular program. Appendix A contains a progress report on that pilot project.

THE HISTORY AND GOALS OF THE PROJECT

During the Pilot Project, members of the Department of Mathematics were exploring more effective ways of utilizing the talents of the faculty and students, the physical facilities, and the various instructional resources. Traditional approaches were being modified and replaced

with new ones emphasizing individualized instruction, independent study, and increased teacher-student interaction. Early in the process of exploring these new approaches, it became apparent that a Study Center designed to handle large numbers of students was of prime importance.

These activities required substantial commitments of time and effort. The success of these efforts depended largely on the extent to which the department members could overcome the tremendous pressure of time. With the hope of overcoming these pressures and bringing to practical reality an instructional system which featured the Study Center, a grant proposal was written and submitted to the Oregon Educational Coordinating Council in March, 1970. A $20,000 grant was approved in April, 1970; the project began in May, 1970; and it is still in progress. Since the project began, about 1000 students have been involved.

Though the primary effort has been concentrated on the development of a system of instruction for the developmental and occupational students, the materials and procedures have been used in transfer and technical courses.

In developing the system, the project team sought to achieve the following objectives:

1. To devise and select measurement devices to ascertain with reasonable certainty which students need remedial training.

2. To develop effective procedures for remedial mathematics instruction to be used at the college and made available to other colleges in the state.

3. To acquire and produce new instructional materials designed and tested to meet the requirements of students seeking to overcome mathematical deficiencies.

4. To improve the effectiveness of the Study Center by reviewing, cataloging, and indexing the study materials.

5. To instigate, supervise and evaluate a system designed to provide the student who has mathematical deficiencies with the skills necessary to improve his chance of success in credit courses, either transfer or technical.

6. To compile a handbook for the careful integration of classroom and laboratory instruction and for the effective assimilation of new instructors and part-time instructors.

Underlining the whole effort has been the hope that attaining the six objectives above would enable more students to succeed in mathematics and develop the appropriate arithmetic base for their career programs.

CHARACTERISTICS OF THE COURSES

The project activities were concentrated on the Developmental courses at Blue Mountain Community College: Basic Mathematics, Elementary Algebra, and Intermediate Algebra. In this section, these courses will be analyzed in terms of the following elements: students, content, and methods. Though not necessarily mutually exclusive, each element will be discussed separately. Since this analysis will identify many of the deficiencies in conventional courses, it can serve as a standard of comparison for the new instructional system.

STUDENTS

Although students enter these courses with a wide range of mathematical skills, these skills are usually quite limited. Not only do many of them have serious deficiencies in topics but many of them are also slow learners. Besides the entry-skills problem, there is also a problem with the attitude of many of the students. Because of a "failure" experience with mathematics, they enter the developmental and occupational math courses with an anxious, defeatist attitude. The teachers assigned to the occupational and developmental math courses usually have little formal training for the assignment. And since they frequently look upon this assignment as a necessary evil, the probability of their spending much time to examine the mathematical needs of these students is very low.

CONTENT

Since occupational and developmental math teachers are frequently uncertain about the proper content for the course, they must rely on the available textbooks for this guidance. However, this content is far from satisfactory. As a core-course, Basic Mathematics must serve students from all majors. The mathematical needs of the various majors are quite diverse, both in terms of topics and the level of sophistication required in topics. Therefore, it is difficult to decide on a core content which fills the needs of all students. On the other hand, it would be almost impossible to design a unique course for students in each curricula. The content has to be somewhat of a compromise. There is also a sequencing problem. Though designed to prepare students for their other courses the math course is taught simultaneously with many of these courses. Given the restrictions of the necessary sequencing of mathematical topics and the speed with which the students can learn, it is almost impossible to treat all topics before they are encountered in the other courses. Topics which are taught "too late" are a constant source of complaint from the students and occupational teachers.

METHOD

In the typical mathematics course the lecture-discussion method is used in conjunction with a conventional textbook. Though it is becoming more and more obvious that this method is not very successful in communicating mathematics to average and below-average students, it is still used for various reasons. For one thing, many teachers will not try any other method, not only because all of their experience and training is with the lecture-discussion method but because it is the method which they enjoy using. For another thing, even those who like to

try a different method find that other methods are not available and they themselves do not have the time and energy to develop one. With students who are experiencing difficulties the lecture-discussion method has many deficiencies. The method places too heavy an emphasis on teacher activity and too little emphasis on student activity. The teacher spends most of the class time lecturing or discussing problems with the students as a group. He does not get enough feedback from each individual student and he cannot devote much class time to remedial work.

CHARACTERISTICS OF THE STUDENTS

This section describes the general characteristics of the entering students and reports their skills in terms of the Blue Mountain Community College Course-Placement Program. Although the information was obtained from the students in the 1970-71 school year, it is typical of the students who have enrolled during the past few years.

GENERAL CHARACTERISTICS

Typically about 2/3 of the mathematics students enroll in the occupational and developmental courses. In the fall, 400 of the 600 mathematics students enrolled in these courses. The general characteristics of these 400 students are summarized below. The information on age, academic major, and mathematics background was available from personal data sheets filled out at the beginning of the term. The age distribution is given in the following table:

AGE	N	%
Less than 20	281	70
20 - 25	78	20
More than 25	41	10
TOTAL	400	100

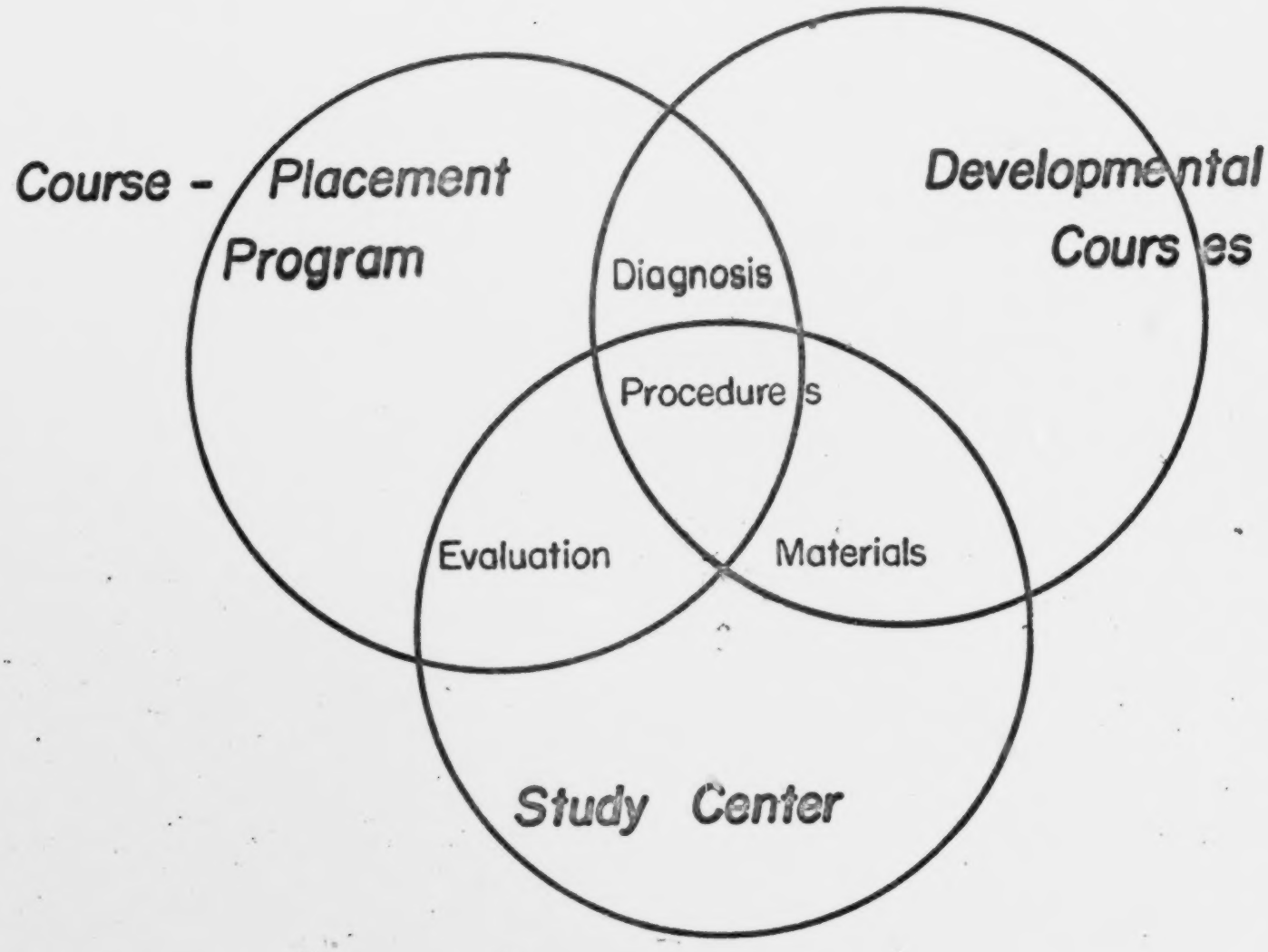
In this group, 175 students (44%) reported that they were in the Liberal Arts division and 225 students (56%) indicated that they were in the Applied Sciences division. 150 of the Applied Science students were enrolled in the Basic Mathematics course. In the table below, the number and percentage of Basic Mathematics students enrolling in each occupational technology are given:

TECHNOLOGY	N	%
Air Traffic Tech	14	9
Broadcasting	9	6
Business	33	22
Law Enforcement	15	10
Mechanical Tech	45	30
Tech Agriculture	15	10
Other	19	13
TOTAL	150	100

The mathematics background information indicated that these entering students were very heterogeneous in terms of their level of high school achievement. In general they have not had a history of academic success. The reported grades were typically average or lower.

ENTRY SKILLS

Each entering student was required to take the Mathematics Course-Placement Exam. Most of the students in the occupational and developmental courses were recommended to these courses because of a general lack of success on this Exam. In particular, Basic Mathematics was recommended for about 36% of these students; Elementary Algebra or equivalent for about 37%; Intermediate Algebra or equivalent for 25%; and a higher level mathematics course for the others. However, about half of these students chose to enroll in Basic Mathematics. One of the reasons students chose this course over a more challenging one was their history of limited success in mathematics. Additional information on entry skills and the Mathematics Course-Placement Exam is contained in chapters 2 and 3.



A system of instruction has been developed to enable more students to succeed in credit courses in mathematics and to develop the appropriate arithmetic base for their career programs. The system has been designed to maximize the opportunity for interactions between the teacher and individual students. It is a departure from conventional instruction in terms of both the content taught and the method used. An effort has been made to incorporate into it the following features: a continual diagnosis of each student's learning difficulties, flexible prescriptions of learning activities (self-study, dialogue and small group study, full class interaction) best suited to each student's skills and knowledge, and a continual evaluation of each student's progress. The system is based on a carefully sequenced and detailed set of objectives. The diagnostic instruments and teaching materials and methods have been correlated to these objectives. The major components of the system are a Course-Placement Program, the Developmental courses offered at Blue Mountain Community College, and the Study Center. In this chapter, one section will be devoted to each of these three major components.

COURSE-PLACEMENT PROGRAM

Entering students differ greatly in the development of their mathematical skills. Recognizing the broad range of skills, the Blue Mountain Community College Department of Mathematics offers a variety of beginning courses in order to provide instruction at all of the appropriate levels. The Course-Placement Program is designed to handle the problem of placing students in the appropriate courses. The ideal course-placement program would route students to a course that would combine challenge with a good opportunity for success. Students who need developmental work to prepare for credit-level study would be routed to a developmental course, not a credit-level course, and students who could succeed in credit-level work would begin at that level rather than in developmental courses. It is unlikely that any placement system would operate perfectly, but by using various means available (tests, high school records, and interviews) placement decisions can be made that at least diminish the amount of error.

This section contains a description of the Mathematics Course-Placement Program that is now being used at Blue Mountain Community College. A discussion of the development of the Program is in chapter 3.

PLACEMENT PROCEDURES

Each entering student is required to take the college placement examination administered by the Counseling Center. Results from this examination are used to determine placement in English, mathematics, and reading courses. Although all students are required to take the placement examinations, no one is denied admission to the College on the basis of scores on these tests. After taking the placement examinations, each student is interviewed by a counselor. During this interview the student's needs, interests, and goals are discussed. Following the interview the student is assigned an adviser who will assist him in planning his academic program. The student who wants to major in a lower division collegiate program is assigned a Liberal Arts division adviser whose interests are in that major. If the student is planning to prepare for a technical occupation, his adviser will be selected from the Applied Sciences department that prepares students for that occupation. The student, assisted by his adviser, selects the most appropriate courses based upon information such as high school records, placement test scores, and recommendations from the Counseling Center.

PLACEMENT EXAM

The mathematics Course-Placement Exam consists of three tests: MOD Arithmetic test, COOP Algebra I test, and COOP Algebra II test. Students whose background includes no algebra take the MOD Arithmetic test. Students who have taken more than two years of mathematics beyond Algebra I take the COOP Algebra II test. Students whose background is between these extremes take the COOP Algebra I test. These 40 minute multiple choice

tests are based on material usually covered in courses through College Algebra. Appendix B contains a list of topics indicating the scope of each of these tests.

PLACEMENT RECOMMENDATIONS

Each test yields a total score based on the number of questions a student answers correctly. This score is used to help make course placement decisions. Each of the tests is being given to students and actual course grades are being matched with resulting test scores. To determine the relationship between these variables and to establish a basis for predicting student performance, norms tables have been developed. The norms tables, in Appendix B, provide a probability of success (C or better) in each course for each score on a respective test.

COURSES

The courses (Basic Mathematics, Elementary Algebra, Intermediate Algebra) are available to those students who, because of a weak background, are not prepared to begin transfer credit courses in mathematics. In addition they are service courses for the career programs which have a mathematics base of arithmetic and algebra. The content of these courses has been analyzed and revised to satisfy these criteria:

1. the content must begin at a level which coincides with the entry skills of the students,
2. the content must satisfy at least one of the following three reasons for inclusion:
   a) it will be used on the job,
   b) it is needed to learn another part of the curriculum, or
   c) it will be required in non-occupational life, and
3. the instruction must proceed at a pace which coincides with the learning speed of the students.

This analysis led to a carefully sequenced set of learning objectives and the development of each of the courses in terms of these objectives. The content of each course has been described by a set of major topics (modules) and by sets of more specialized subtopics (units). In this section the courses will be described by identifying the content, procedures, materials, and diagnostic instruments in each course.

BASIC MATHEMATICS

At the beginning of the term each student takes a comprehensive diagnostic test to determine his particular needs. This test identifies each student's needs in terms of the following major topic-modules of the course:

Topic-Modules

A. Place Value
B. Whole Numbers I (operations)
C. Whole Numbers II (primes, involution and evolution)
D. Fractions I (multiplication and division)
E. Fractions II (addition and subtraction)
F. Decimals
G. Ratio and Proportion
H. Percent

A more detailed description of these same topics (objectives) is given in Appendix C. Individual progress in the course is made by students through the use of textbooks, self-instruction materials found in the Study Center, small group work, and dialogue with

the teacher. As the term passes, the individual student monitors his progress on a weekly basis.

The first day of each week the instructors provide large group instruction -- the Monday lecture on a major topic. The lectures identify the objectives for each topic-module and provide various ways to approach these objectives. Following the lecture the student is given his weekly assignment. When a student completes the assignment for that topic-module, he requests the topic-module test at the Study Center. Sample copies of the topic-module tests are in Appendix C. After he takes the test, it is evaluated by the instructor and the results are discussed with the student in an evaluation interview. The interview is a brief review of the test, which either confirms the student's mastery of the content or diagnoses areas in which the student needs additional study. If the student has mastered the concepts of the topic-module, his work for that week is completed. This "time off" feature serves as motivation for many students and allows the teacher to give individual attention to the students who need the help. If the student does not achieve initial success on the test, addition instruction is prescribed -- work with the materials in the Study Center, small group sessions in the classroom, or individual sessions with the instructor. When the student is again confident that he can pass the topic-module test, he requests a parallel form of the original test at the Center. After he takes this test, there is another evaluation interview. This procedure continues until the student shows mastery of the concepts and skills developed in the topic-module.

This weekly pattern continues for eight of the ten weeks in the quarter. The first week is used for course orientation activities and the last week is available for "makeup and catchup" activities. The teacher's handbook, described in Appendix C, contains comments, teaching suggestions, and a description of these procedural details. At the end of the term, a comprehensive final examination is given to determine the student's grade.

ELEMENTARY ALGEBRA

The following outline indicates the major topics (modules). A more detailed description of the same content (including the specialized subtopics or units) is given in Appendix D.

Topic-Modules

A. Sets, Variables, and Sentences
B. Integers, Rational Numbers, and Real Numbers
C. Fractional Expressions and Polynomials
D. Solving Sentences

The audio-tutorial method of studying mathematics is used in this course. This method utilizes a textbook-workbook designed to correlate with audio tapes. The lecture and other explanations are on audio tapes and the chalkboard illustrations are in the text. The students

spend two hours per week in discussion classes devoted to answering student questions, taking tests, and solving problems introduced by teacher-made worksheets. For three hours a week, on the average, the students use the audio-tape and text materials in the Library Learning Center. A student goes to the Library with his book, pencil, and paper; checks out a tape; proceeds to a study carrel; and studies a topic-unit. The student can go through the lecture at his own rate and review any part of the lecture as often as desired by reversing the tape player and turning back in the text. The student spends as much time as necessary to complete a unit. When he feels he has mastered the basic concepts of a unit, he requests a test at the Study Center. After he takes the topic-unit test, it is evaluated by his instructor who reports the results and further recommendations to the student on a redirect sheet. The redirect sheet indicates which questions the student has missed and which frames to review. If the student has not mastered the concepts of the unit he is given remedial assignments - referral back to the audio tapes, work with materials in the Study Center, or individual sessions with the instructor.

During the term each student has many opportunities to judge his progress in the course. In addition to the tests associated with each of the 25 topic-units, there are problems at the end of each unit that the student is required to work and hand in for evaluation. There are four mid-terms (topic-module tests) taken in class. The instructor keeps the students informed concerning the results of these progress checks by using a special form that is distributed on a regular basis throughout the term. The topic-module test scores carry the most weight in the determination of course grades. Appendix D contains copies of the material and tests used in the course.

INTERMEDIATE ALGEBRA

The content of this course is described by six topic-modules:

A. Real Number System,
B. Linear Equations and Inequalities,
C. Polynomials,
D. Fractional Expressions,
E. Exponents, Roots, and Radicals, and
F. Quadratic Equations.

The teachers use a combination of informal lectures, small group work, and chalkboard recitations to get active student participation in the class. Although the topics are introduced to all students at the same time, each student's progress on a topic is evaluated daily. The progress check usually takes the form of a short answer topic-unit test which is given in class. Each of these topic-unit tests covers a basic concept essential to the study of the topic-modules listed above. These progress checks identify formally for each student his need for a review of the topic-unit. The evaluation of these topic-unit tests is one of

the unique features of this course. The teachers prescribe a review for any student who fails to answer the test questions 100 percent correctly. Those students whose errors are not directly on the concept being tested are asked to simply retake various forms of the test until they eliminate all such errors. Those students who show a misunderstanding of the basic concept being tested are prescribed the program of Study Center activities best suited to their skills and knowledge of the topic unit content. This prescription is communicated to the student on a referral form which indicates the Study Center activity and the topic-unit test the student should take when he completes the activity. After the student takes the second topic-unit test, at the Center, it is evaluated by the instructor, using the same standard of 100 percent mastery of the concept. This process is repeated until the student answers the test questions correctly. The availability of about 10 forms of each topic-unit test makes it possible for a student to take a different form of the test each time. Most students master a topic-unit concept within one recycle. No student has had to retake a topic-unit test more than four times. The philosophy of expecting 100 percent mastery of each topic-unit concept, which is reflected in the following grading policy, had a desirable effect on the classroom atmosphere. The grade on each quiz was determined as follows:

5 points if done correctly in class,
4 points if done correctly on the first retake,
3 points if done correctly on the second or third retake,
2 points if done correctly anytime after the third retake, and
0 points if the student doesn't fulfill any of the above criteria for points.

This system rewards the student for being prepared for a given class and at the same time allows each student a second chance to learn a concept. Course grades for the students are determined by topic-unit tests, the topic-module tests, and the final exam. Appendix E contains copies of the materials and tests used in the course.

OTHER COURSES

Some of the materials and procedures that were developed for the instructional system are used in the transfer and technical courses. The topic-unit testing procedure as described in the Intermediate Algebra section is used in the College Algebra, Trigonometry, and Technical Mathematics courses. Students in these and the other mathematics courses at Blue Mountain Community College use the materials and tutorial services that are available in the Study Center.

STUDY CENTER

The Study Center is an area containing programmed materials, audo-visual devices, books, calculators, and other resources which supplement and reinforce the general curriculum at Blue Mountain Community College. It is staffed by teaching assistants, faculty members, and student tutors. The mathematics section of the Center is designed to provide a workable source of mathematics instruction for all Blue Mountain Community College students. The Center provides two types of learning programs:

1) the instructional system program in which the Center is an integral part of the regular mathematics courses and
2) an independent study program in which the student works on his own under the guidance of a teacher.

Both of these programs feature easily accessible instructional materials and readily available tutorial guidance.

INSTRUCTIONAL SYSTEM PROGRAM

The resources used in the instruction system program are a Test File, which is used to find out what instruction a student needs, and a Set of Materials, which is designed to give him that instruction. These resources were selected and designed to correlate with the mathematics courses offered at Blue Mountain Community College. The resources are used to make Study Center activities an integral part of each course offered within the instructional system. These courses are designed so that each student is required to take several tests in the Center. This was done in part to assure personal contact between the student and the Center personnel. Once this contact is made the student discovers the many advantages that the Center offers.

As indicated in the previous section, each of developmental courses has been divided into topic-modules and topic-units which specify the objectives in each course. Each objective was defined in terms of test items and references to specific presentations in various instructional materials. These test items, which are in the Test File in the Center, make up the topic-unit and topic-module tests that are used in each course. The details of the testing procedure were described in the previous sections. In general the tests are used to diagnose deficiencies and to evaluate progress after instruction. The development of the material references led to a thorough analysis of the Center resources. These resources, which include a variety of teaching machines and programs, tape recorders and tapes, programmed texts, textbooks, and other materials designed for self-study, were reviewed, catalogea, and indexed for easy reference to the topics. The resulting Index contains references to the best material available for studying each of the various topics. The instructor uses the Index to identify materials that will help the student overcome his topical deficiencies. He finds the topic in the Index and selects the assignment, directing the student instantly to the pages in a particular book, to the side of a particular tape, or to the cartridge for a particular teaching machine. The student then may

proceed at his own pace and at his own convenience, seeking tutorial assistance when the need arises.

The management of many features of the instructional system from the Study Center has given the system a flexibility that was virtually impossible under any other type of management. This flexibility has made possible such extra servies as special treatment for fast or slow learners, tutoring at any time during the day, and an efficient method for handling the make-up work of absentees.

INDEPENDENT STUDY PROGRAM

The resources of the Study Center are available to all Blue Mountain Community College students, as well as all members of the community, for independent study. Although the Department of Mathematics has developed a series of course to fit most mathematical needs, there are some people who need to work outside of these course offerings. The independent study program provides ways for these people to fulfill their needs. This program offers the student whose education has been interrupted and is now returning to college the chance to "brush up" before entering regular classes. It allows the adult who has never been to college the opportunity to study without the pressures of the classroom. The student with a learning problem has the opportunity to study without the pressures of the classroom. The student with a learning problem has the opportunity to overcome his weaknesses without embarrassment.

In addition, the student with a scheduling problem can take an entire mathematics course in the Study Center. The following independent study courses are available:

1) Basic Mathematics (Mth 40)
2) Elementary Algebra (Mth 45)
3) Intermediate Algebra (Mth 95)
4) College Algebra (Mth 101)
5) Trigonometry (Mth 102)
6) Analytic Geometry (Mth 110)
7) Calculus (Mth 200)

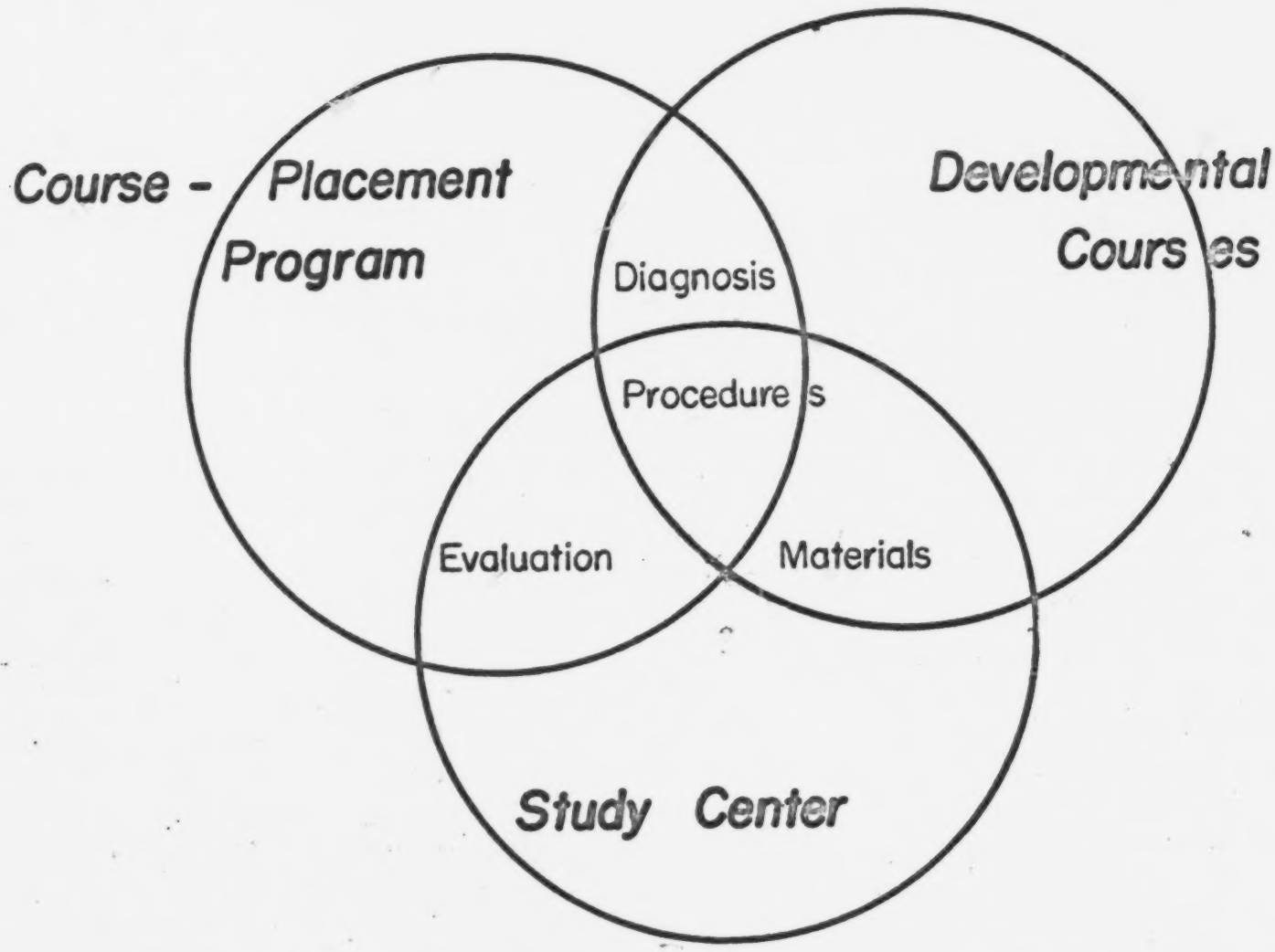
Each course can be easily administered by a mathematics teacher working as a tutor-guide in the Center. For each course, the materials have been organized into packages which contain

A text and other materials needed by the student,
A course outline and time schedule for the student,
A student guide which explains his responsibilities,
An instructor guide which lists the major objectives of the course and defines the instructor's role in the course
A test booklet which contains all quizzes, hour tests, and the final exam in a form ready for student use, and
An answer book for all tests.

Also available are a number of "mini-courses" in areas of mathematics which are heavily used by students in school work and in everyday life. "Mini-courses" are available in slide rule use, solving linear equations, solving quadratic equations, solving word problems, solving systems of linear equations, and many others which are developed as the demand arises. The material developed for each mini-course consists of packages containing

An information sheet explaining the procedures and the objectives of the course,
A collection of self-evaluation quizzes, and
Materials, such as a programmed text or an audio tape, which are necessary to fulfill the objectives of the course.

The Basic Pharmacology course for practical nurses provides an illustration of the materials, testing, and tutorial features of the Study Center. Students of nursing, like other persons, vary in their ability to use mathematics. However, it is important that nurses know how to add, subtract, multiply, and divide when dealing with fractions, decimals, percentage, ratio, and proportion. The "arithmetic review" and the "mathematics of dosage and solutions" parts of the Pharmacology Course have been designed to assist these students in developing and maintaining these computational skills. A continual diagnosis of each nurse's strengths and weaknesses, using SRA's Computational Skills Development Kit, in the Center makes it possible for each to work only on those computational skills in which she is weak. The materials and tutor-guides provide individual assistance when it is needed. When a nurse finishes with the mathematics part of the course - 50% usually take one week, 25% need three weeks, and the remaining 25% take about five weeks - she uses the mathematics in the nursing lab as she works with her nursing teacher on the techniques of administering drugs.



A system of instruction has been developed to enable more students to succeed in credit courses in mathematics and to develop the appropriate arithmetic base for their career programs. The major components of the system are a Course-Placement Program, the Developmental courses offered at Blue Mountain Community College, and the Study Center.

Since the primary goal of any system of instruction is to make learning occur, the success of the system should be measured in terms of the achievement of this goal. This chapter contains empirical results and comments on the learning that occurred during the fall and winter terms, 1970-71. These results will be reported under the following headings:

A. Course-Placement Program
B. Basic Mathematics Course
C. Elementary Algebra Course
D. Intermediate Algebra Course
E. Study Center
F. General Comments

COURSE-PLACEMENT PROGRAM

Each entering student was required to take the college placement examination administered by the Counseling Center. Results from this examination were used to determine placement in English, mathematics, and reading courses. Although all students were required to take the placement examinations, no one was denied admission to the College on the basis of scores on these tests. After taking the placement examinations, each student was assigned an advisor who assisted the student in planning his program.

The mathematics portion of the college placement examination has undergone many changes in the last few years. During the spring of 1970 a Mathematics Course-Placement Program based on high school records, test scores, and interviews was developed. This Program was used, analyzed, and refined. This section describes these activities under the headings: placement (1970) and placement (1971).

PLACEMENT (1970)

The mathematics Department constructed a two-level exam based on the material usually covered in standard mathematics courses through Intermediate Algebra. A student took the Level I test if he had a weak algebra background and the Level II test if he had a strong algebra background. The exam was given to 73 Blue Mountain Community College Mathematics students to establish tentative norms. After the Counseling Center gave the exam to about 300 high school seniors in the College district, the norms were reviewed and specific standards were established. The following table indicates the standards that were established:

COURSE-PLACEMENT RECOMMENDATIONS (1970)

Test	Raw Score	Course-placement recommendations
Level I	0 - 7.5	Basic Mathematics
	8 - 11.5	Elementary Algebra or equivalent
	12 - 20	Intermediate Algebra or equivalent
Level II	0 - 2	Elementary Algebra or equivalent
	3 - 12	Intermediate Algebra or equivalent
	13 - 22	College Algebra or higher

Placement beyond College Algebra was done on an individual basis using additional information.

The exam was given to approximately 1000 students during the spring, summer, and fall of 1970. 410 of the 600 fall term mathematics students took the exam. Level I test results for 306 students indicated that 148 should take Basic Mathematics, 115 should take Elementary Algebra or equivalent, and 43 should take Intermediate Algebra or equivalent. 104 Level II tests predicted success for 35 students in Elementary Algebra or equivalent, for 60 students in Intermediate Algebra or equivalent, and 9 students in College Algebra or beyond. To summarize, Basic Mathematics was recommended to 36% of these students, Elementary Algebra to 37%, Intermediate Algebra to 25%, and College Algebra to 2%. After consultation with counselors and advisors, the students enrolled in the following courses and achieved the following results:

COURSE-PLACEMENT RESULTS (1970)

Recommended Course (number)	Course taken (number)	Successful (%) (A,B,C)	Unsuccessful (D,F,W)
Basic Mathematics (148)	Basic Mathematics (118)	68 (58%)	50 (42%)
	Higher Level (30)	7 (23%)	23 (77%)
Elementary Algebra (150)	Lower Level (32)	28 (88%)	4 (12%)
	Elementary Algebra (95)	69 (73%)	26 (27%)
	Higher Level (23)	11 (48%)	12 (52%)
Intermediate Algebra (103)	Lower Level (25)	19 (76%)	6 (24%)
	Intermediate Algebra (71)	48 (68%)	23 (32%)
	Higher Level (7)	4 (57%)	3 (43%)

Analysis of these results, together with related data, led to a refinement of the test. Actual grades were correlated to a number of prediction instruments. For example, Basic Mathematics information resulted in a correlation coefficient of .63 in relating the 1970 placement test scores and the actual grades; whereas the COOP Arithmetic test, Form A, comparison resulted in correlation coefficient of .54. But in Elementary Algebra the correlation coefficient between the results of the COOP Algebra I test, Form A, and the grades were .43 compared to .34 when comparing the 1970 placement test scores and actual grades. In Intermediate Algebra, the following information was obtained: COOP Algebra I test scores compared with grades, .54; 1970 placement test scores compared with grades, .41. Information of this nature provided guidelines for the revision of the exam. Appendix B contains some of the data that was used in analyzing the exam. Included in the redesign was the attitude that the method of placement should be as simple as possible to relieve the Counseling Center and the Mathematics Department of complicated procedures.

PLACEMENT (1971)

The refinements in the 1970 Placement Model led to a three-level model based on test scores, high school records, and personal interviews. The following tests are being used:

Level I:	MOD ARITHMETIC
Level II:	COOP ALGEBRA I
Level III:	COOP ALGEBRA II

Students whose background includes no algebra take the Level I test; students who have taken more than two years of mathematics beyond Algebra I take the Level III test; and students whose background in between these two extremes take the Level II test. These 40 minute multiple choice tests are based on material usually covered in courses through College Algebra.

The Level I test was developed by the BMCC Department of Mathematics. It is the product of three years of writing, revising, and norming. The first 28 questions of this test were used as the Basic Math Diagnostic Test in 1970-71. The COOP tests are available from the Cooperative Test Division, Educational Testing Service, Berkeley, California. Appendix B contains a copy of the MOD ARITHMETIC TEST and a list of topics indicating the scope of each of the tests.

Each test yields a total score based on the number of questions a student answers correctly. Each of the tests have been given to students and actual course grades have been matched with resulting test scores. This activity provided norms tables, in Appendix B, which indicate a probability of success (C or better) in each course for each score on a respective test.

BASIC MATHEMATICS COURSE

Basic Mathematics was taught to four classes (194 students) during the fall term and one class (58 students) during the winter term. This section summarizes the results obtained. The diagnostic test, topic-module tests, pre-test and post-test, the final examination, course grades, and dropout rates will be examined.

DIAGNOSTIC TEST

At the beginning of the term each student took a comprehensive diagnostic test to determine his particular needs. The results of this test served as a basis for prescribing a program for each student to follow throughout the term. The program recommended for a student specified certain objectives that the student should be able to accomplish as a result of his study. A different set of objectives were selected for each student, based upon that student's mastery of the total objectives displayed in the diagnostic test. The test included items from the following categories: Whole Numbers I, Fractions I, Fractions II, Decimals, and Percents. A copy of one form of this test is given to Appendix C. A distribution of scores and an item analysis are also in Appendix C. These topics describe five of the eight weekly modules in the course. The remaining topic-modules are Place Value, Whole Numbers II, and Ratio and Proportion. A complete set of test data was available for 184 students in the fall and 47 students in the winter. The mean scores were 54% and 49%, respectively. The mean scores (% of correct answers) on each of the five sub-sections of the test are given in the table below:

Mean Scores for Sub-Sections of BASIC MATH DIAGNOSTIC TEST

	Fall, 1970	Winter, 1971
Whole Numbers I (6 items)	76%	78%
Fractions I (6 items)	43%	42%
Fractions II (5 items)	60%	47%
Decimals (7 items)	54%	49%
Percents (4 items)	32%	20%

This information indicated that most of the students needed considerable instruction on Fractions I (multiplication and division) and Percents. Whereas most students could succeed in the course with little time spent on Whole Numbers I.

The diagnostic test was also used as a course placement test. Scores on the test were correlated with actual grades in the various courses. These results, which are provided in Appendix B, indicated that the test should be used to predict student success in the lower level courses. Next year, the test will be administered as part of the Course-Placement Exam.

TOPIC-MODULE TESTS

The course was divided into eight topic-modules. Each week when a student completed his initial assignment for that week's topic-module, he requested a test in the Study Center. After he took the test, it was evaluated by the teacher and the results were discussed with the student in an evaluation interview. The interview included a brief review of the test which either confirmed the student's mastery of the topic-module or diagnosed areas in which the student needed additional study. If the student did not achieve initial success (70% or better), additional instruction was prescribed and retesting was done with parallel forms of the original topic-module test. The following tables summarize the results obtained on the topic-module tests:

TOPIC-MODULE TESTS
(Fall, 1970)

Mean Scores and Number Taking Tests

Topic-Module	Form A	Form B	Form C	Form D	Form E	Form F
1. Place Value	.75 (180)	.80 (57)	.81 (18)	.90 (8)	.85 (2)	1.00 (1)
2. Whole Numbers I	.89 (174)	.85 (6)	1.00 (1)	(0)	(0)	(0)
3. Whole Numbers II	.76 (165)	.67 (55)	.81 (22)	.81 (11)	.77 (7)	.92 (6)
4. Fractions I	.77 (158)	.72 (46)	.65 (24)	.72 (13)	.74 (8)	.82 (7)
5. Fractions II	.86 (154)	.67 (17)	.64 (8)	.77 (6)	.58 (3)	.70 (2)
6. Decimals	.64 (153)	.68 (71)	.72 (36)	.68 (17)	.69 (10)	.81 (6)
7. Ratio and Proportion	.73 (146)	.68 (39)	.64 (19)	.69 (12)	.76 (6)	.80 (3)
8. Percent	.69 (140)	.66 (57)	.65 (27)	.61 (10)	.84 (5)	(0)
Average Number Taking Tests	(159)	(44)	(19)	(10)	(5)	(3)

These results provide information concerning several features of the course. The weekly topic-module pacing is illustrated by the success, on the average, of 115 of the 159 students after initial instruction, by the success of 25 of the remaining 44 after additional instruction, 9 of 19, 5 of 10, 2 of 5, and finally the last 3.

TOPIC-MODULE TEST
(Winter, 1971)

Mean Scores and Number Taking Tests

Topic-Module	Form A	Form B	Form C	Form D	Form E	Form F
1. Place Value	.81 (58)	.82 (10)	.95 (2)	(0)	(0)	(0)
2. Whole Numbers I	.85 (56)	.78 (4)	.90 (1)	(0)	(0)	(0)
3. Whole Numbers II	.66 (55)	.73 (26)	.73 (16)	.86 (6)	.80 (2)	.95 (1)
4. Fractions I	.75 (53)	.76 (16)	.82 (5)	.85 (3)	.75 (1)	(0)
5. Fractions II	.74 (50)	.77 (16)	.76 (6)	.75 (3)	.73 (2)	.70 (1)
6. Decimals	.60 (49)	.69 (29)	.79 (15)	.95 (1)	(0)	(0)
7. Ratio and Proportion	.73 (48)	.71 (14)	.63 (4)	.70 (1)	(0)	(0)
8. Percent	.67 (48)	.71 (22)	.57 (12)	.69 (5)	.70 (2)	(0)
Average Number Taking Test	(52)	(17)	(7)	(2)	(1)	(0)

The winter results indicate that, on the average, the initial instruction provided by the Monday lecture was all that was needed by 35 of the 52 students. The remaining 17 students received the attention for the rest of the week with 10 of these 17 succeeding after another look at the topic-module. Sample copies of the topic-module tests are in Appendix C.

PRE-TEST AND POST-TEST

The COOP Arithmetic tests, Forms A and B, were given to the students in the course as pre-tests and post-tests. The results obtained from these tests provided information which was used to judge several other diagnostic instruments: the course-placement exam, the diagnostic test, and the final examination. The means during fall term for four of the instruments were Diagnostic Test (.54), Pre-test (COOP Arithmetic, Form A) (.62), Post-test (COOP Arithmetic, Form B) (.66), and Final (.77). These and similar results indicated that the COOP Arithmetic tests would not provide useful information on the course.

FINAL EXAM SCORES, COURSE GRADES, DROPOUT RATES

The final examination was designed to measure the student's general knowledge of arithmetic and its applications. The final examination was taken by 140 students in the fall and 50 students in the winter, with the scores ranging from 49% to 98% and 55% to 97%. The mean and median scores for the final exam were 77% and 79% in the fall and 75% and 76% in the winter. A copy of the final exam and an analysis of the exam are included in Appendix C.

The official droput rate was about 20% (40 of 194) in the fall and 14% (8 of 58) in the winter. However the 20% figure includes 9% who withdrew after one session. A 20% dropout rate compares favorably to the 40% dropout rate which had occurred when the course was taught by conventional methods. The majority of the dropouts occurred for nonacademic reasons.

Course grades for the students were determined by their score on the final exam. The distribution of grades is given in the table below.

Distribution of Course Grades - Basic Mathematics

Grade	Fall, 1970 N	Fall, 1970 %	Winter, 1971 N	Winter, 1971 %
A (90% - 100%)	19	13	4	8
B (80% - 89%)	48	31	12	24
C (65% - 79%)	50	32	24	48
F	8	5	5	10
I	29	19	5	10
TOTAL	154	100%	50	100%

The students that received grades include 76% who succeeded in the fall and 80% in the winter. The remaining students had the opportunity to finish the course in the following term.

Comparing initial success on each topic-module test with the comparable sub-section of the Diagnostic Test and comparable sub-sections of the final test indicates the relative success of the course. The following tables provide this comparison.

COMPARISON OF MEAN SCORES
(Fall, 1970)

Topic-Module	Diagnostic Test	Topic-Module Test FORM A	Final Test
Whole Numbers I	.76 (6 items)	.89	.91 (17 items)
Fractions I	.43 (6 items)	.77	.85 (10 items)
Fractions II	.60 (5 items)	.86	.74 (2 items)
Decimals	.54 (7 items)	.64	.76 (11 items)
Percents	.32 (4 items)	.69	.76 (14 items)

The final success of the students on these 5 sub-sections was 82% compared to 54% success at the beginning of the term.

COMPARISION OF MEAN SCORES
(Winter, 1971)

Topic-Module	Diagnostic Test	Topic-Module Test FORM A	Final Test
Whole Numbers I	.78 (6 items)	.85	.88 (17 items)
Fractions I	.42 (6 items)	.75	.87 (10 items)
Fractions II	.47 (5 items)	.74	.84 (2 items)
Decimals	.49 (7 items)	.60	.77 (11 items)
Percents	.20 (4 items)	.67	.67 (14 items)

The final success of the students on these 5 sub-sections was 80% compared to 49% success at the beginning of the term.

COMMENTS ABOUT BASIC MATHEMATICS

We believe that the 1970-71 trial of the Basic Mathematics course was successful. Most of the goals for this course were attained. The Course-Placement Exam did a good job of identifying the students who needed the Basic Mathematics Course. Each case of incorrect placement occurred because the student and his advisor did not follow the placement suggestion.

The following innovations were particularly successful: the Monday lectures, the weekly topic-module tests, the Study Center activities, and the individual evaluation interviews. The textbook was one of the weakest parts of the course. This was recognized in the course planning but available time was alloted to developing the procedures and other materials. The application part of the course was not ready to implement completely, but is being given further attention.

Teacher and student evaluations brought about some changes for winter and spring terms. A copy of the student survey results is in Appendix C. The student record form was redesigned to make it more useful and a supplementary record was adopted. The students believed that the weekly topic-module tests should count toward the final grade. To add this incentive a grading scale was designed to include this feature.

ELEMENTARY ALGEBRA COURSE

Elementary Algebra was taught to six classes (157 students) in the fall and eight classes (198 students) in the winter. The original plan was to use the audio-tutorial approach in all of the classes. However, the hardware to handle them all was not available at the beginning of the fall term and fall term experiences indicated that other approaches should be used. During the fall term four classes (49 students at Blue Mountain Community College and 53 students at Linn-Benton Community College) used the audio-tutorial approach and two classes (55 students at BMCC) used a programmed text approach. During the winter term four classes (31 students at BMCC and 65 students at LBCC) used the audio-tutorial approach, one class (30 BMCC technical agriculture students) used a problem solving approach, and three classes (72 BMCC students) used a combination of the other two approaches.

The audio-tutorial approach that was used in the fall utilized the audio-tutorial project materials developed at Fullerton Junior College and procedures designed to emphasize problem solving in algebra. The approach was developed to serve the Elementary Algebra needs of the Liberal Arts students and the Applied Science students. However, experiences during the fall and winter terms suggested that two different courses should be available to serve these needs. The Applied Science students for whom Elementary Algebra was a terminal course in algebra needed more emphasis on problem solving and less on the foundations of algebra. The students for whom Elementary Algebra was a course which would lead to Intermediate Algebra and beyond needed the flexibility provided by the audio-tutorial approach. These two courses, Mth 4.202 (Applied Elementary Algebra) and Mth 45 (Elementary Algebra), are now available at BMCC. Mth 4.202 is being developed with the cooperation of faculty members in the Applied Science division. Mth 45 designed to qualify the student with little or no background in algebra for Intermediate Algebra, has been developed and utilizes the audio-tutorial approach. This section summarizes the results obtained in the development of Mth 45.

The audio-tutorial method utilized a textbook-workbook designed to correlate with audio tapes. The lecture and other explanations were on audio tapes and the chalkboard illustrations were in the text. The student spent three hours per week in discussion classes devoted to answering student questions, solving problems introduced by teacher-made worksheets, and taking the topic-module tests. For three hours a week, on the average, the student used the audio-tape and text materials in the Library Learning Center. A student went to the Library with his book, pencil, and paper; checked out a tape; proceeded to a study carrel; and studied a unit. The student could go through the lecture at his own rate and review any part of the lecture as often as desired by reversing the tape player and turning back in the text. The results of these activities will be examined in terms of the topic-unit tests, topic-module tests, pre-test and post-test, the final examination, course grades, and dropout rates.

TOPIC-UNIT TESTS

When the student finished a topic-unit tape and felt that he had mastered the basic concepts of the unit, he requested the appropriate topic-unit test at the Study Center. After he took the test, it was evaluated by his instructor who reported the results and recommendations to the student on a redirect sheet. The redirect sheet indicated which questions the student missed and which frames in the textbook-workbook explained the answers to these questions. When the student received a score of 70% or less on the test, he was required to retake the test when he was again ready. The following table summarizes the results obtained on the topic-unit tests during the fall term classes at Blue Mountain Community College.

TOPIC-UNIT TESTS

Average Scores and Number Taking Test

Topic-Unit	Original %	(N)	Retake #1 %	(N)	Retake #2 %	(N)	Topic-Unit	Original %	(N)	Retake #1 %	(N)	Retake #2 %	(N)
A 1.	74	(49)	90	(8)	91	(2)	B 5.	70	(42)	82	(11)	88	(2)
A 2.	84	(49)	87	(7)	80	(1)	B 6.	78	(42)	78	(8)	89	(1)
A 3.	86	(49)	85	(4)		(0)	B 7.	82	(41)	88	(5)		(0)
A 4.	80	(48)	78	(6)	84	(1)							
A 5.	84	(48)	85	(4)		(0)	C 1.	84	(40)	79	(3)		(0)
A 6.	83	(47)	79	(9)	83	(2)	C 2.	80	(38)	87	(5)	90	(1)
A 7.	89	(47)	84	(4)		(0)	C 3.	76	(38)	84	(7)	70	(1)
A 8.	85	(45)	89	(4)		(0)	C 4.	91	(36)		(0)		(0)
							C 5.	81	(36)	84	(4)		(0)
B 1.	80	(45)	84	(5)	80	(1)	C 6.	78	(36)	85	(6)	80	(1)
B 2.	82	(45)	79	(7)	84	(1)	D 1.	77	(36)	81	(6)	77	(2)
B 3.	88	(44)	85	(2)		(0)	D 2.	67	(36)	79	(7)	88	(1)
B 4.	48	(43)	79	(38)	84	(5)	D 3.	76	(36)	78	(6)		(0)

When examining this table, the following points should be considered:

1) This table illustrates the typical topic-unit testing pattern that has evolved.
2) There have been some changes in the tests from term to term. The major change has been to change their format to multiple choice problems to facilitate grading and analysis.
3) The winter results were not tabulated because the classes were being refined into the two seperate courses.

TOPIC-MODULE TESTS

During the term each student had many opportunitites to judge his progress in the course. In addition to the tests associated with each of the 25 topic-units, there were problems at the end of each unit that the student was required to work and hand in for evaluation. There were three mid-terms (topic-module tests) taken in class, the fourth topic-module test is part of the final exam. The instructors kept the students informed concerning the results of these progress checks by using a special form that was distributed on a regular basis throughout the term. The topic-module test scores carried the most weight in the determination of course grades. The fall term results at Blue Mountain Community College are reported below:

TOPIC-MODULE TESTS

Topic-Modules	Mean Score	N	Standard Deviation
A. Sets, Variables, and Sentences	75%	45	10.56
B. Integers, Rational Numbers, and Real Numbers	67%	41	14.34
C. Fractional Expressions and Polynomials	66%	39	16.86
D. Solving Sentences	59%	34	19.08

These results indicate the pacing pattern that brought about certain refinements in the course. In particular, as the term progressed, the mean scores decreased, the number of students decreased, and spread of scores increased. These observations led to procedures which would allow more flexibility in providing for individual differences. The course now requires mastery of a topic-module before the next one is encountered and allows time for this to be accomplished with variable credit arrangements.

PRE-TEST AND POST-TEST

The COOP Algebra I tests were utilized as a pre-test, form A was given on the first regular day of class, and as a post-test, form B was administered during the final week. The results obtained show evidence that the approach is effective with most students. During the fall and winter terms,

the mean raw score on the pre-test was about 13

and the mean raw score on the post-test was about 25.

This 92% gain encouraged the continued development of the course. Additional information from these tests contributed to the development of the new Course-Placement Program.

FINAL EXAM SCORES, COURSE GRADES, DROPOUT RATE

During the fall term there was a 26% (27 of 102) dropout rate. However only 11% dropped after the second week and 70% of the students who dropped also quit school.

There were two final exams: a takehome final that emphasized problem solving and a regular final on concepts. These exams were taken by 36 students at Blue Mountain Community College and 38 students at Linn Benton Community College. The scores ranged from 19% to 91% on the takehome final and from 45% to 98% on the regular final. The mean scores on the takehome final and the regular final were 65% and 75%, respectively.

Course grades were determined by scores on the final exams, the topic-unit tests, the supplementary problems, and the topic-module tests. The distribution of grades is given in the table below.

ELEMENTARY ALGEBRA
(Fall, 1970)

DISTRIBUTION OF COURSE GRADES

Grade	N	%
A	14	19
B	13	18
C	40	53
D	7	9
F	1	1
TOTAL	75	100

COMMENTS ABOUT ELEMENTARY ALGEBRA

The results achieved by the students using the audio-tutorial approach show promise. The teachers who handled the classes was quite enthusiatic about these results. They pointed out that the students seemed to appreciate the discussion periods since the attendance was good. The audio-tutorial environment with its flexibility and accessibility of instruction provided students the opportunitites to develop the abilities they possessed. It was especially helpful for the student who felt some responsibility for his own learning. Teacher and student evaluations of the approach brought about changes in the course. A copy of the student survey is in Appendix D. This survey, which was based on the Fullerton Junior College attitude questionnaire, concerned student attitudes, feelings, and reactions to the course. Students felt that the most beneficial features of the approach were the ability to stop and repeat tapes, the ability to enter the lab at their hour of convenience and as often as needed, periodic testing, and small group discussion sessions.

INTERMEDIATE ALGEBRA (1970)

Intermediate Algebra was taught to four classes (100 students) during the fall term. This section summarizes the results obtained during that term and discusses the course refinements that occurred during the winter and spring terms. The topic-unit tests, topic-module tests, pre-test and post-test, the final examination, course grades, and dropout rates will be examined.

TOPIC-UNIT TESTS

The teachers used a combination of informal lectures and chalkboard recitations. Although the topics were introduced to all students at the same time, each student's progress on a topic-unit was evaluated almost daily. The progress check usually took the form of a short answer topic-unit test, form A. These tests identified formally for each student his need for a review of the topic-unit. If the teacher discovered individual weaknesses, he prescribed the program of Study Center activities best suited to each student's skills and knowledge of the topic-unit content. This prescription was communicated to the student on a referral form which indicated the Study Center activity and the topic-unit test, form B, the student should take when he completed the program. The topic-unit test results are summarized in the following table:

TOPIC-UNIT TESTS

Mean Scores and Number Taking Test

Topic-Unit	Form A	Form B
A 1.	.45 (86)	.72 (42)
A 2.	.63 (86)	.63 (13)
A 3.	.70 (88)	.65 (11)
A 4.	.75 (86)	.76 (13)
A 5.	.80 (93)	.90 (8)
A 6.	.84 (88)	.80 (3)
A 7.	.70 (87)	.68 (9)
B 1.	.66 (82)	.60 (13)
B 2.	.68 (83)	.76 (13)
B 3.	.67 (84)	.75 (15)
B 4.	.84 (80)	.80 (5)
B 5.	.78 (81)	.75 (4)
B 6.	.65 (81)	.72 (11)
B 7.	.76 (79)	.80 (10)
B 8.	.71 (80)	.65 (10)
B 9.	.73 (81)	.60 (10)
C 1.	.72 (81)	.67 (5)
C 2.	.86 (78)	1.00 (4)
C 3.	.88 (77)	(0)
C 4.	.73 (77)	(0)
D 1.	.82 (76)	.95 (4)
D 2.	.86 (77)	.80 (3)
D 3.	.62 (77)	.69 (16)
D 4.	.77 (79)	.67 (6)
E 1.	.62 (78)	.65 (18)
E 2.	.70 (77)	.67 (14)
F 1.	.70 (79)	.84 (12)
F 2.	.84 (79)	.93 (8)
F 3.	.74 (79)	.86 (8)
F 4.	.76 (78)	.85 (10)
F 5.	.81 (79)	.90 (10)
F 6.	.63 (79)	.63 (19)

It should be pointed out that the people who took Form B of the topic-unit tests were students who scored 40% or less on Form A of the test together with students who had excused absences from the first test. In particular, there was a group of students who consistently scored low on the first test and then, given time and help in the Study Center, consistently scored high on the second test. These students, about 8% of the class, successfully completed the course. It seems likely that they would have been unsuccessful otherwise.

Another point of interest is the results of test A 1 (Form A), where about 50% of the students were referred to the Study Center for further work. The student scores never approached this low level again. This can be attributed to a general "awakening" which often occurs when students perform poorly. The significant point here is that the "awakening" occurred during the second class meeting, rather than at mid-term. This seemed to set a standard for achievement and an atmosphere of alertness which carried on throughout the term.

TOPIC-MODULE TESTS

The content of course consists of six topic-modules: (A) Real Number System; (B) Linear Equations and Inequalities; (C) Polynomials; (D) Fractional Expressions; (E) Exponents, Roots, and Radicals; and (F) Quadratic Equations. There were 3 mid-term tests given throughout the term. Test I (topic-modules A and B) had a mean score of 71.1%; Test II (topic-modules C and D) had a mean score of 76.6%, and Test III (topic-modules E and F) had a mean score of 67.9%. The distribution of the grades for these tests are given in the table below.

TOPIC-MODULE TESTS

Distribution of Grades

Grade	Test I		Test II		Test III	
	N	(%)	N	(%)	N	(%)
A	16	(20)	26	(33.3)	12	(15.4)
B	30	(37.5)	26	(33.3)	9	(11.5)
C	12	(15)	11	(14.1)	21	(26.9)
D	14	(17.5)	11	(14.1)	18	(23.1)
F	8	(10)	4	(5.2)	18	(23.1)
Total	80	(100%)	78	(100%)	78	(100%)

The instructors of this course noticed that the first test seemed to confirm the placement information which had been gathered. A number of the students were convinced at this point that their placement in a lower level math class was justified and withdrew at this time. A few of the students remained unconvinced and remained in the class. None of these students were successful, although a few earned Ds by diligently making use of the Study Center facilities. The grades on test III were noticeably lower because of the test took too long to complete. This test was shortened before it was used in the winter term.

PRE-TEST AND POST-TEST

The COOP tests, Algebra I and Algebra II, were given to the students in the course. The results obtained from these tests were used to judge several diagnostic instruments. The COOP Algebra I test results indicated that this test was one of the best predictors of student success in Intermediate Algebra. The Algebra II test results are being used to predict success in the College Algebra course.

FINAL EXAMS, COURSE GRADES, DROPOUT RATES

The official dropout rate was 24.05%. However, the majority of these dropouts occured for nonacademic reasons.

Course grades for the students were determined by their scores on the topic-unit tests, the topic-module tests, and final exam. The distribution of grades is given in the following table:

DISTRIBUTION OF COURSE GRADES

Grade	N	%
A	10	13
B	13	17
C	16	20
D	16	20
F	5	6
W	19	24
Total	79	100%

COURSE REFINEMENTS

During the winter term the results were not as good as had been expected. The primary cause for concern was the lack of student initiative in completing Study Center assignments. In addition there were some students who completed their Study Center assignment and gained from the additional work, but still did not completely master the given topic-unit. These variations in the pattern from fall term were attributed mostly to the type of student enrolled in the Intermediate Algebra classes during winter term. The winter term student had a weaker mathematics background and had a history of a lack of success in mathematics. Although their scores on the placement examination were lower than those for students in the fall term, their scores were high enough for placement into Intermediate Algebra. The winter term experience prompted several refinements in the course procedures.

Successful experimentation in classes such as College Algebra, Trigonometry, and Technical Mathematics gave rise to revisions in the testing procedures in Intermediate Algebra. Each topic-unit test was expanded to ten or more forms. This was done in order to give the student an opportunity to recycle through a topic-unit and have a chance to check his mastery with a fresh test each time. The use of a ditto master containing an outline of the test with the particular numbers, or problem, omitted enabled the instructors to produce a number of forms of each test without much difficulty. The next revision was in the method of test evaluation. Rather than giving the student partial credit for an incorrect solution to a topic-unit test, the instructor told the student to take another form of the test. This process was repeated until the student answered the test question correctly. Each retake lowered the student's score as follows: no retakes was an A; one retake was a B; two or three retakes was a C; and four or more retakes was a D. *Notice that the student cannot* score less than a D unless he fails to retake the given topic-unit test. This grading system encouraged the student to completely master each topic unit, rather than compromising for partial credit. The third and final revision was one of emphasis. The lecture time was reduced and there was an increased amount of time spent on boardwork and small group activity. This made the class more informal and tended to get the students more involved in the classroom work.

COMMENTS ABOUT INTERMEDIATE ALGEBRA

The Intermediate Algebra instructors were pleased with the results obtained in the Intermediate Algebra classes during fall term and with the revised system as it was taught spring term. The course was successful with the average students of fall term and the lower level students of spring term. The outstanding features of this class were:

1. The organization of the material and the order in which it was presented seemed natural and easy to teach.
2. The short quizzes proved to be an effective teaching device.
3. The idea of 100% mastery on the topic-units created a positive atmosphere for learning.
4. The referral form was a valuable communication device between teacher and student.
5. The use of the Study Center has shown great potential. Several students have had rather outstanding success working in the Center.
6. The system encouraged the student to see the instructor more often.

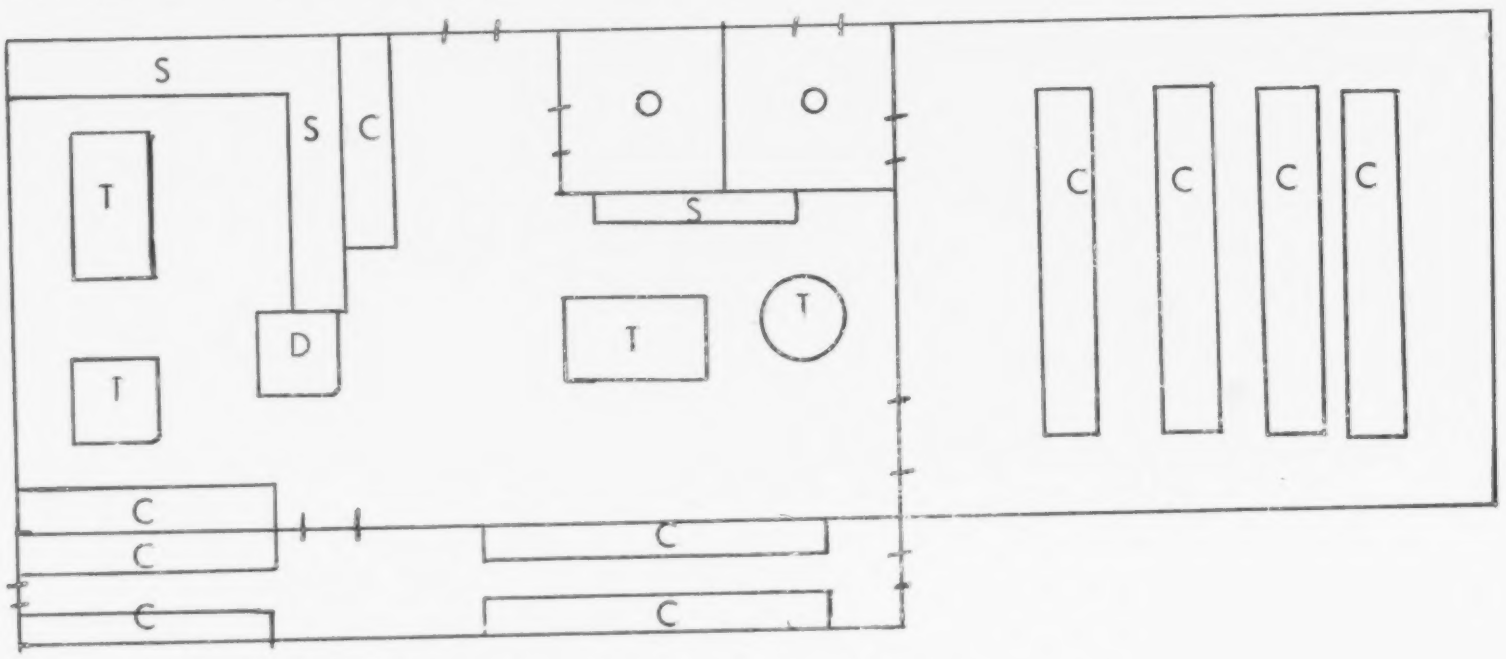
STUDY CENTER

The management of many features of the instructional system from the Study Center has given the system a flexibility that was virtually impossible under any other type of management. This facility had a major impact on the entire mathematics program at the college. During fall term, 1970, over 3000 student contacts were made as part of the work in the three Developmental courses. These courses were designed to make Center activities an integral part of each course. Each student was required to take several tests in the Center and use the instructional material that was available there. This section describes the Study Center activities during the fall in terms of the Study Center resources, the Developmental courses, and the general results.

STUDY CENTER RESOURCES

The Study Center contains programmed texts (about 200 different titles), tape recorders and tapes (60 SRA Mathtapes, 63 Merrill Audio tapes, 54 Houghton Mifflin Algebra tapes, 4 Slide Rule tapes), a variety of teaching machines and programs (20 MAST cartridges, 15 TUTORFILM films), and other materials designed for self-study (SRA Computational Development Kit, SRA Algebra Skills Kit). These materials have been reviewed, cataloged and indexed for easy reference to the topics taught in courses in the system. The Study Center Test File contains the topic-module and topic-unit tests for each course. The procedures in each course required that a student take several of these tests in the Center. A full-time clerk handled the administration of these tests at the student's convenience. The Center was manned 5 days a week, 8 hours a day, by a full-time tutor-clerk. A part-time student clerk was on duty 15 hours per week. Each of the seven mathematics instructors averaged about 5 hours per week assisting students in the Center.

The Study Center is located in an area between the Library and Student Union, making it easily accessible to the students. The facility has two components: a quiet area used mainly for testing and a tutorial area.



D - Desk, O - Office, T - Table, C - Carrel, S - Storage

DEVELOPMENTAL COURSES

In the Basic Mathematics course, there were 1738 module tests taken in the Study Center. On the average, a student took 15 minutes for a test. The total time for test-taking in the Center was about 343 hours and 30 minutes; this is an average of 8.7 hours per day throughout the term. Each of these tests was followed by an evaluation interview. About half of these interviews resulted in a recommendation of additional Center activity: individual tutoring, use of instructional materials, or both.

Due to the limited space in the Study Center facility, activities in the Elementary Algebra course over flowed to the Library. The Library handled most of the checking out of tapes and housed the eleven study carrels where permanent tape players were located. Each student averaged 2.3 hours per week listening to tapes. Each student took at least 25 topic-module tests in the Center, averaging 20 minutes per test. At least 1125 tests were given, resulting in a total test time of about 375 hours, or 7.5 hours per day.

In the Intermediate Algebra course, student deficiencies were determined by using progress checks in class. Those students who needed work were referred to the Study Center. Their referral form indicated the material that they should study and the topic-unit test that they should take when they were ready. There were 340 referrals made throughout the term. This resulted in the following time being spent in the Center: 57 test taking hours and 114 material use hours.

GENERAL RESULTS

At any given time, students from as many as 20 different mathematics classes were using the Center on a regular basis. While early use was predominantly in the Developmental courses, there was a continued growth of use by students in the transfer and technical courses. As the system evolved, the teachers recognized that the Center enabled them to spend more time guiding individual students and small groups. Teachers felt that their students showed more interest in the courses, asked more questions, and demonstrated deeper understanding in small - and large - group discussions. In addition, the teachers felt that they got to know the students better as their role shifted from lecturer to tutor-guide. It appears that the multimedia approach makes the instructional system effective for certain topics and students and is a step toward the ideal of an individualized program of instruction for mathematics students.

GENERAL COMMENTS

In this section, the accomplishments of the project will be summarized and discussed. This discussion will lead into a broader discussion of the implications of the project and the many future directions which the project can take.

ACCOMPLISHMENTS

The system of instruction that has been developed has enabled more students to succeed in mathematics. Though the system is neither completed nor perfect, the specific goals of the project have been accomplished. The project team has been able

1) To devise and select measurement devices to ascertain with reasonable certainty which students need remedial training,

2) To develop effective procedures for remedial mathematics instruction,

3) To acquire and produce new instructional materials designed and tested to meet the requirements of students seeking to overcome mathematical deficiencies,

4) To improve the effectiveness of the Study Center by reviewing, cataloging, and indexing the study materials,

5) To instigate, supervise, and evaluate a system designed to provide the student who has mathematical deficiencies with the skills necessary to improve his chance of success in credit courses, either transfer or technical, and

6) To compile handbooks for the careful integration of classroom and laboratory instruction and for the effective assimilation of new instructors and part-time instructors.

The general goal of enabling more students to succeed in credit courses in mathematics and to develop the appropriate arithmetic base for their career programs has been attained. The team has been maintaining data on the progress of the students in successive courses and this data seems to verify these conclusions concerning the general success of the system.

Each student and each instructor involved in the courses were asked to comment on the strengths and weaknesses of the system. Each teacher submitted a report and each student filled out a questionnaire at the end of the term. The attitude of the students toward the system of instruction has been very positive. This positive attitude is undoubtedly related to the level of achievement which they attained. Though many of the students began the courses with a fair amount of anxiety because of their past experience with math courses, their success dissipated this anxiety and replaced it with confidence in their ability to learn.

Though asked to assume a new role, the cooperation of the teachers during the course of the project has been very good. Nine different teachers have been involved at some time during the year. They have worked out more or less well depending upon their skills at tutoring and controlling students plus their ability to function as a member of a highly organized group. Since a system of instruction cannot survive in our educational system if teacher reaction to it is negative, there has been a necessary concern about the attitudes of the teachers. At first, some of the teachers were apprehensive. In spite of their willingness to try something new, there was a conflict between their new role and the role which an ordinary teacher expects to play in his profession. Some teachers admitted that they missed lecturing and were disturbed by the fact that the students were learning without their lectures. Most were fairly conscious of their status, with a fear that their new role was merely that of a technician or bookkeeper. As the learning system evolved and the teachers became more involved in it, their attitudes became more positive. There are various reasons why this change in attitude occurred. Some of the reasons are more general and some are specifically related to the use of the Study Center. The more general reasons are:

(1) The instructional system has been successful and most teachers are interested in the achievement level of their students.

(2) It became clearer to them that their role was also a highly professional one. That is, they saw that the system was designed so that they could cope with the learning problems of individual students. Most of them found this type of activity rewarding.

(3) They became more involved in the decision-making process of the project and so their ideas and suggestions had an influence on changes in the system.

The reasons related specifically to the use of the Study Center are:

(1) Full utilization of the many resources of the Center makes it possible for teachers to function in their most important role - teaching.

(2) The increased use of para-professional personnel (teacher aides and clerical help) freed the teachers from many of their non-professional duties.

There are many reasons for the success of the system of instruction developed by the project team. The system is highly organized and it provides for interactions between the teacher and individual students. It has objectives which are clear both to the teacher and the student and only these objectives are assessed by test items. It has demonstrated that average and below-average students can learn mathematics from the multimedia approach. The results achieved by the project suggest that a system of instruction like the one developed by the project team should be developed for mathematics instruction at other levels. A system of instruction of this type not only guarantees individual attention for each student, but it is also flexible enough to deal with individual differences in these students.

FUTURE DIRECTIONS

What has been accomplished by the project up to this point is a mere beginning. The project staff has many ideas about directions which the project can and should take in the future. These future directions include various ways in which the present system of mathematics instruction can be expanded and modified to fill a much broader need. This expansion needs to be done with mathematics for transfer students, mathematics for occupational and technical students, and mathematics for elementary and secondary school students.

The major problem with most students at the transfer level is that the students feel no responsibility for their own education. The system approach can shift this responsibility from the instructor to the student where it rightfully belongs. By eliminating the lock step schedule, the instructor can involve the student more actively in his own learning. To achieve these objectives, the other mathematics courses at Blue Mountain Community College are being added to the system of instruction.

Considering the fact that most of the mathematics instruction is remedial in nature, it might be more efficient at the present time to concentrate on systems of mathematics instruction for high school students. If the major effort were devoted to high school courses, there would be a need for coordination with mathematics instruction in elementary and junior high schools.

In order to facilitate the development of the many systems of instruction which are necessary, a statewide center should be established. The recently established Math and Science Curriculum Resource Center for Oregon, sponsored by the Oregon Museum of Science and Industry, could serve this role as it helps set the stage for a "Systems Approach" in Oregon.

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APPENDIX A

Date: February 16, 1970

From: Larry Mitchell, Mathematics Department

To: Mr. Wallace McCrae, President

Subject: Occupational and Developmental Project

INTRODUCTION

In recent years there has been an increased awareness among community college mathematics teachers of the need to improve the effectiveness of instruction and the appropriateness of course content in their occupational and developmental mathematics offerings. As a consequence there has been much interest in meetings devoted to discussions of these offerings. This interest has motivated a search for innovative approaches to mathematics for occupational and developmental students. Many schools have inaugurated programs to meet the needs of these students.

During the past two years, the Blue Mountain Community College Mathematics Department has been developing an approach centered around the study skills center. Our approach has been based upon the hypotheses that

(1) the student won't learn until he sees the importance of the material and

(2) Instruction should be almost entirely individualized.

PURPOSE

The purpose of this report is to present the results to date in the project being carried out to improve our occupational and developmental offerings.

APPENDIX A

SCOPE

The complete scope of the project includes for each course:

(1) identifying and listing pertinent topics,
(2) preparing diagnostic tests relative to these topics,
(3) preparing mastery tests for these topics,
(4) preparing study materials for those topics, and
(5) cataloging and indexing study materials by topics.

To date, activities have been concentrated on areas 1, 2, and 4. These activities have been devoted to the arithmetic and elementary algebra levels.

METHOD

Program

The sequence, Mth 4.200 (Arithmetic) and Mth 4.202 (Elementary Algebra), is the primary vehicle for the program. It serves as a sequence for both Liberal Arts and Applied Science students. These courses are designed for those students who, because of a weak background, are not prepared to begin transfer credit courses in mathematics. In addition they are service courses for the career programs which have a mathematics base of arithmetic and elementary algebra.

Objectives and Procedures

To indicate the progress that we have made with this project, I choose to examine what we have done in terms of our guiding principles.

(1) Start each student as nearly as possible at his own level of mathematical development. This principle presents at least two immediate problems.

(a) How do you determine where a student's first level of difficulty lies?

(b) How can you let each student in a class work at exactly his own level?

The first problem has a solution. We are developing a testing program to determine the course that the student should be placed in. Also, there are several diagnostic tests available to identify the student's mathematical level within the course. The problem of enabling each student to work at his own level in a classroom situation is not as easily solved. But we think that we can solve it with our second principle.

(2) Instruction should be almost entirely individualized. We are preparing a flexible list of topics and assignments in arithmetic, elementary algebra, and their applications that proceeds from the first operations on whole numbers to the more complicated topic needed for their program. Each student after taking the first diagnostic test is started on this sequential list at his own level and then continues down the list.

This brings us to our third principle.

(3) The students should be allowed to work at their own rate. After a student is started on his list of topics and assignments, he moves forward as rapidly as he can. When understanding comes quickly, the teacher need not give lengthy assignments. If understanding is slow in coming, the teacher can give more individual help and extra assignments in the Study Skills Center.

This brings us to our fourth principle.

(4) A variety of source material must be provided. Having diagnosed the student's problem, the teacher refers the student to the Study Skills Center. The teacher and Mrs. Harris then establish a skills program for the student to follow. The student's performance on the program is evaluated at the end of each lesson and his progress and performance determine the specific materials and techniques that will be employed on subsequent visits to the Center. The student's lessons, diagnostic information, etc. are kept in his record folder. The student is responsible for maintaining a majority of his records. During this activity, the student is aided by the instructor, Mrs. Harris, Mrs. Ferguson, and volunteer student help. We try to have several different kinds of material - books, workbooks, handout sheets, programmed books, math tapes, skill kits, etc. - for the student. Never is the student expected to work the same exercise over and over until he "gets it right". Fresh material on the same topic is used when needed.

The fifth principle is closely related. The virtue of the sequence is its fresh approach to old topics. When teaching courses of high school level, it had been the custom to repeat the material in essentially the same form as it was presented in high school. For students who were not successful in high school, this approach was often no more fruitful the second time than the first.

(5) The student won't learn until he sees the importance of the material. It is our conviction that there is a large group of students in the occupational curricula who are strongly motivated by seeing specific applications. These students want to be immersed as quickly as possible in nursing, electronics, policescience, or secretarial subjects; that's what they came for. At all times in teaching these courses, every effort is made to illustrate and motivate the material in them by showing how it is used in a large variety of

applications. Primarily this is handled by using handout sheets. The students are given sets of word problems selected to show how the material can be applied to their area of study.

These sets of word problems are being developed with the cooperation of many of the Applied Science departments. This cooperation resulted from several meetings devoted to discussions of approaches to the problem, attitudes toward the problem, levels of exercises, etc.

The Agriculture and Air Technology Departments have been excellent in contributing to this collection of applications. Other departments that have cooperated include Mechanical Technology, Civil, Practical Nursing, Police Science, and Business. Other sources of applications include the future mathematics courses that some of the students will take, as well as many of the other Liberal Arts areas.

This brings us to our sixth principle.

(6) The students must be given the chance to succeed. This is essential. Some of these students have histories of failure. Therefore learning must proceed in steps small enough so that each student can make some progress or achieve some success. As soon as a student can see that he too can learn, that he too can make progress, he is willing to work. But the very nature of this sort of student is such that he must see this success often, several times every hour if possible. This does not mean that work must be "watered down" so that anyone can succeed with just a "twist of the pencil." Assignments must be short so that a student can check his progress in short intervals and so that misunderstandings can be discovered immediately, and corrected before frustrations set in.

For this pupose programmed materials in theory ought to be ideal since students can check themselves after every problem. There is one serious difficulty with programmed material. Since most programmed material relies heavily on reading skills it usually offers no solution to the student who cannot read well. There are some exceptions. But the other kinds of materials are available to the student too.

Evaluation

Although our principles are not especially new or unique, what is unique is that we are trying to provide situations where they can be applied and we are achieving some successes because of them. The students feel that they are correcting mistaken ideas and developing a good base on which to continue.

APPENDIX A

WORK TO BE DONE

As was noted in the discussion, a good deal of work is still needed. Specific things must be done such as:

(1) identifying and listing of pertinent topics. This activity requires even more cooperation between the departments. The occupational components of the sequence can only be determined by objective study conducted by both mathematics teachers and technology teachers.

(2), (3) preparing of diagnostic and mastery tests relative to these topics. Although there are several of these tests available for the arithmetic portion, we need to develop them for the elementary algebra portion.

(4), (5) preparing, cataloging and indexing study materials for these topics. We need to continue to collect and to develop sets of problems which are related to each level of the sequence. Our arithmetic portion requires more problems which have been documented and are at the same time realistic illustrations. In order to provide examples from all branches of the technologies, we need more variety than we now have.

These activities require substantial commitments of time and effort. The accomplishment of the above goals will depend largely on the extent to which we can overcome the tremendous pressure of time. We need to seek ways to make this time available.

M O D ARITHMETIC TEST, FORM A

BLUE MOUNTIAN COMMUNITY COLLEGE

Pendleton, Oregon 97801

GENERAL DIRECTIONS

This is a 40-minute test. Do not spend too much time on any one question. If a question seems to be too difficult, make the most careful guess you can, rather than waste time over it. Do not worry if you do not finish the test. Your score is the number of correct answers you mark.

Use scratch paper to work problems. Do not make any marks in your test booklet.

Mark all answers on the separate answer sheet. Make your answer marks heavy and black. Mark only one answer for each question. If you make a mistake or wish to change an answer, be sure to erase your first choice completely.

Note how the answer to the EXAMPLE below is marked on your answer sheet.

EXAMPLE

$$\frac{4 \div 6}{2} = (?)$$

A 2
B 3
C 5
D 7
E 8

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO.

ARITHMETIC | 40 MINUTES

1. Add:

7	A	47
8	B	36
7	C	46
9	D	48
8	E	none
7		

2. Subtract:

54	F	37
-27	G	27
	H	36
	J	28
	K	none

3. Subtract:

90,080	A	36,614
-53,476	B	36,504
	C	37,514
	D	37,604
	E	none

4. Multiply:

509	F	27,572
x408	G	207,672
	H	24,432
	J	204,572
	K	none

5. Divide: (Indicate if there is a remainder. Example, 7 ÷ 3 = 2 R1)

9) 5,382	A	578
	B	575 R7
	C	598
	D	620 R2
	E	none

6. Divide:

87) 59,296	F	681 R59
	G	680 R36
	H	704 R48
	J	681 R 49
	K	none

7. Reduce 1 24/36 to lowest terms:

A	1 1/3
B	1 2/3
C	1 3/2
D	2/3
E	none

8. Change 18 2/3 to an improper fraction:

F	56/3
G	58/3
H	46/3
I	39/3
K	none

9. Multiply: The answer must be in simplest form:

2/3 of 6/7

A	7/9
B	12/21
C	2/7
D	4/7
E	none

10. Multiply:

5 1/2 x 6 x 7/22

F	2 1/3
G	1 10/11
H	3/44
J	10 1/2
K	none

11. Divide: The answer must be in simplest form.

2/3 ÷ 3/4

A 1/2
B 8/9
C 1 1/2
D 2
E none

12. Divide: (Same as above)

3 1/2 ÷ 5 1/4

F 3/8
G 1 1/2
H 2/3
J 2/2
K none

13. Add: (to be correct, the answer must be reduced to lowest terms with improper fractions changed to mixed numbers.)

1/6 + 3/6

A 4/6
B 4/3
C 1/3
D 2/3
E none

14. Add: (Same as above)

1/3 + 1/5

F 1/4
G 8/15
H 4/15
J 1 7/8
K none

15. Add: (Same as above)

8 3/4 + 7 7/10

A 16 9/20
B 15 5/7
C 15 9/20
D 16 7/20
E none

16. Subtract: Do not forget the answer must be simplified.

3/4 - 3/8

F 3/4
G 1/2
H 3/8
J 1 1/2
K none

17. Subtract: (Same as above)

4 5/8 - 2 7/8

A 1 23/24
B 1 3/8
C 1/8
D 2/8
E none

18. Select the correct value of the missing number:

302/10,000 = ?

F .0302
G .00302
H .0302
J .302
K none

19. Change to a decimal: (Example - 1/16 = .0625 or .06 1/4)

5/8

A 62 1/2
B .625
C 5.8
D 6.25
E none

20. Change to a common fraction in lowest terms:

.025

F 1/40
G 1/20
H 2/5
J 1/4
K none

21. Add:

21.68 + .563 + 1.4

A 23.643
B 28.71
C 22.383
D 2.2643
E none

22. Subtract:

5.06 − 4.982

F .078
G .178
H 7.8
J 4.5818
K none

23. Multiply:

3.27 x .79

A 2,583.3
B 25.833
C .25833
D 2.5833
E none

24. Divide:

1.216 ÷ .04

F 30.4
G 3.08
H 34
J 3.4
K none

25. Change 7.3% to a decimal:

A 7.3
B .73
C .0073
D .073
E none

26. Change each to the equivalent per cent:

23/1,000

F 2.3%
G 230%
H 23%
J .023%
K none

27. Find 16% of 2.4:

A .0384
B 38.4
C 3.84
D .384
E none

28. Find the per cent:

6 is ?% of 15

F 60%
G 6%
H 2 1/2%
J 25%
K none

29. If two owls eat an average of seven mice every four days, how many mice will they devour in a thirty-day month?

A 210
B 105
C 52 1/2
D 15
E none

30. 7 yd. 2 ft. = _____ inches

F 65
G 276
H 252
J 324
K none

31. If $2x + 1 = 7$, then $x = (?)$

A $\frac{1}{4}$
B $\frac{1}{3}$
C 3
D 4
E 11

32. The statement, "A certain number f increased by twice another number n is equal to 30," can be written

F $f + 2n = 30$
G $f + 2f = 30$
H $2f + n = 30$
J $2f + 2n = 30$
K $2nf = 30$

33. $(-5) - (-9) = (?)$

A -14
B -4
C 4
D 14
E 45

34. If $x = y = z = 1$, then $\frac{x - y}{x + z} = (?)$

F -2
G -1
H 0
J $\frac{1}{2}$
K 1

35. $-6x + 5x - 9x = (?)$

A $-16x$
B $-14x$
C $-11x$
D $-6x$
E $-2x$

36. If n is an even number, what is the next larger even number?

F $n - 2$
G $n - 1$
H $n + 1$
J $n + 2$
K $2n$

37. What is the coefficient of y in the expression $2y^5 + 5y^4 - 4y^2 - 5y + 1$?

A -5
B -1
C 1
D 2
E 5

38. If $A = LW$ and if $A = 12$ and $L = 3$, then $W = (?)$

F $\frac{3}{4}$
G 3
H 4
J 12
K 36

39. $\frac{x^7}{x^3} = (?)$

A $x^{3.5}$
B x^4
C x^{10}
D x^{21}
E 3.5

43. Which of the following is equivalent to $x(x+a) - a(x-a)$?

F $(x+a)(x-a)^2$
G $(x+a)^2(x-a)$
H $(x+a)^3$
J $(x+a)^2$
K $x^2 + a^2$

Level I Test: MOD ARITHMETIC, Form A

Whole Numbers (Addition and Subtraction) - 1, 2, 3
Whole Numbers (Multiplication and Division) - 4, 5, 6
Fractions (Equivalent Fractions) - 7, 8
Fractions (Multiplication and Division) - 9, 10, 11, 12
Fractions (Addition and Subtraction) - 13, 14, 15, 16, 17
Decimals (Conversions) - 18, 19, 20
Decimals (Addition and Subtraction) - 21, 22
Decimals (Multiplication and Division - 23, 24
Percents (Conversions) - 25, 26
Percents (Formulas) - 27, 28
Ratio and Proportion (Applications) - 29, 30
Solution of Linear Equations - 31
Translation from Verbal to Algebraic Expressions - 32, 36
Combining Terms - 33, 35, 40
Substitution in Algebraic Expressions and Equations 34, 38
Terminology - 37
Exponents and Roots - 39

Level II Test: COOP ALGEBRA I, Form A

Terminology - 7
Combining Terms - 3, 5, 10
Translation from Verbal to Algebraic Expressions - 2, 6, 19, 30
Solution of Linear Equations - 1, 13, 23, 38
Subsitution in Algebraic Expressions and Equations - 4, 8, 20, 26
Solution of Literal Equations - 16, 39
Exponents and Roots - 9, 14, 22
Algebraic Multiplication and Division - 15, 21, 25, 28
Averages - 17
Systems of Linear Equations - 11, 31
Graphs of Linear Functions - 12, 32
Linear Inequalities and Order - 29, 33, 35, 40
Factoring and Quadratic Equations - 18, 24, 34, 37
Division by Zero - 27
Variation - 36

Level III Test: COOP ALGEBRA II, Form A

Operations with Algebraic Expressions - 2, 5, 9, 15, 22
Roots and Powers of Numbers - 1, 6, 8, 11, 34
Solution of Linear Equations and Inequalities - 3, 33, 36
Solution of Quadratic Equations and Inequalities - 4
Solution of Systems of Equations and Inequalities - 7, 13, 20, 25
Solution of "Word Problems" - 10, 30
Properties of Linear Functions - 12, 17, 28
Properties of Quadratic Fractions - 19, 23, 27, 31, 36, 40
Factoring - 18
Progressions - 14, 24
Logarithms - 16, 39
Exponential Equations and Equations Involving Radicals - 21, 26
Complex Numbers - 29, 32
Evaluation of a Function - 35
Absolute Value - 37

PROBABILITY OF SUCCESS
based on the test results with
Level 1 Test: MOD Arithmetic, Form A

Test Results		Probability of Success in-	
	Raw Score	Basic Mathematics	Elementary Algebra	Intermediate Algebra
BASIC MATHEMATICS	0	36%	6%	.3%
	1	40%	7%	.5%
	2	43%	8%	.8%
	3	45%	9%	1%
	4	47%	10%	1%
	5	49%	12%	2%
	6	51%	13%	3%
	7	53%	15%	4%
	8	55%	17%	5%
	9	57%	21%	6%
	10	59%	25%	6%
	11	60%	28%	7%
	12	62%	31%	8%
	13	64%	34%	10%
	14	66%	38%	12%
	15	67%	41%	14%
	16	69%	45%	16%
	17	71%	49%	17%
	18	73%	51%	19%
	19	75%	53%	21%
	20	78%	56%	23%
	21	80%	59%	25%
	22	82%	61%	28%
	23	84%	62%	31%
	24	86%	65%	35%
ELEMENTARY ALGEBRA	25	88%	68%	38%
	26	89%	70%	41%
	27	90%	72%	44%
	28	91%	74%	48%
	29	92%	76%	52%
	31	95%	80%	57%
	32	96%	82%	61%
	33	97%	83%	63%
	34	97%	85%	66%
INTERMEDIATE ALGEBRA	35	98%	87%	70%
	36	99%	88%	73%
	37	99.2%	89%	74%
	38	99.4%	90%	76%
	39	99.5%	92%	78%
	40	99.6%	93%	79%

PROBABILITY OF SUCCESS
based on the test results with
Level II Test: COOP Algebra I, Form A

Test Results		Probability of Success in		
	Raw Score	Elementary Algebra	Intermediate Algebra	College Algebra
BASIC MATHEMATICS	0	13%	2%	.3%
	1	17%	4%	.8%
	2	21%	5%	1%
	3	25%	6%	1%
	4	28%	8%	2%
	5	31%	9%	3%
	6	34%	11%	4%
	7	38%	13%	4%
	8	41%	15%	5%
	9	45%	17%	6%
	10	49%	19%	7%
	11	51%	21%	8%
	12	56%	24%	10%
	13	58%	27%	12%
	14	62%	30%	14%
	15	66%	34%	16%
ELEMENTARY ALGEBRA	16	69%	38%	18%
	17	72%	41%	20%
	18	75%	45%	22%
	19	78%	48%	25%
	20	80%	52%	28%
	21	82%	56%	31%
	22	85%	60%	35%
	23	87%	63%	39%
	24	89%	66%	42%
INTERMEDIATE ALGEBRA	25	90%	70%	46%
	26	92%	73%	50%
	27	93%	76%	54%
	28	94%	79%	57%
	29	95%	82%	61%
	30	96%	84%	64%
COLLEGE ALGEBRA	31	97%	86%	68%
	32	97%	88%	71%
	33	98%	90%	74%
	34	98.2%	91%	77%
	35	98.6%	92.5%	79%
	36	98.8%	94%	82%
	37	99.1%	95%	84%
	38	99.3%	96%	86%
	39	99.5%	97%	88%
	40	99.7%	98%	89%

PROBABILITY OF SUCCESS
Based on the test results with
Level 1A Test: COOP Algebra II, Form A

	Test Results	Probability of Success in		
	Raw Score	Intermediate Algebra	College Algebra	Calculus
ELEMENTARY ALGEBRA	0	19%	5%	2%
	1	21%	6%	3%
	2	23%	7%	3%
	3	25%	8%	3%
	4	27%	9%	4%
	5	29%	10%	5%
	6	31%	11%	6%
	7	34%	12%	7%
	8	37%	15%	9%
	9	40%	17%	9%
	10	42%	20%	13%
	11	45%	24%	16%
	12	48%	27%	19%
	13	52%	30%	22%
	14	56%	33%	25%
	15	60%	37%	29%
	16	63%	40%	32%
	17	66%	44%	36%
INTERMEDIATE ALGEBRA	18	69%	48%	39%
	19	72%	50%	43%
	20	75%	52%	46%
	21	77%	55%	50%
	222	79%	58%	53%
	23	80%	60%	56%
	24	81%	62%	59%
	25	82%	64%	62%
COLLEGE ALGEBRA	26	83%	67%	64%
	27	84%	69%	67%
	28	87%	71%	69%
	29	89%	73%	71%
	30	91%	75%	73%
	31	93%	77%	76%
	32	94%	79%	78%
	33	95%	81%	80%
CALCULUS	34	96%	82%	82%
	35	97%	83%	84%
	36	98%	85%	86%
	37	98%	87%	88%
	38%	99%	88%	89%
	39	99.1%	89%	91%
	40	99.2%	90%	92%

APPENDIX B-6

COURSE-PLACEMENT PROGRAM DETAILS

The statistical data that was used to analyze and develop the program is on file at Blue Mountain Community College. Information concerning these details may be obtained from

Harold Hauser
Department of Mathematics
Blue Mountain Community College
Pendleton, Oregon 97801

APPENDIX C - 1

DESCRIPTION OF COURSE CONTENT

BASIC MATHEMATICS (Math 40)

There are eight major topic-modules in the course. They are

A. Place Value
B. Whole Numbers I (operations)
C. Whole Numbers II (primes, involution and evolution)
D. Fractions I (multiplication and division)
E. Fractions II (addition and subtraction)
F. Decimals
G. Ratio and Proportion
H. Percent

The specific content of each topic-module is described in this appendix.

A. Place Value

1. Numbers and Numerals
2. Decimal System
3. Exponents
4. Expanded Notation using Exponents

B. Whole Numbers I

1. Addition and Subtraction
   - 1.1. Simple Addition
   - 1.2. Addition with Carrying
   - 1.3. Simple Subtraction
   - 1.4. Subtraction with Borrowing
   - 1.5. Subtraction borrowing from Zero
   - 1.6. Subtraction borrowing from Zero twice

2. Multiplication and Division
   - 2.1. Simple Multiplication
   - 2.2. Multiplication Algorithm
   - 2.3. Multiplication with Zero
   - 2.4. Simple Division with even answers
   - 2.5. Simple Division with a remainder
   - 2.6. Division Algorithm
   - 2.7. Long Division

C. Whole Numbers II

1. Primes and Composites
2. Involution and Evolution

D. Fractions I

1. Equivalent Fractions
   - 1.1. Simple Equivalent Fractions
   - 1.2. Reducing Equivalent Fractions
   - 1.3. Changing to Improper Fraction

2. Multiplication and Division
   - 2.1. Simple Multiplication
   - 2.2. Multiplication involving mixed numbers
   - 2.3. Multiplication involving combinations
   - 2.4. Division involving whole numbers and fractions
   - 2.5. Simple Division
   - 2.6. Division involving mixed numbers

E. Fractions II

1. Addition and Subtraction
   - 1.1. Equivalent Fractions
   - 1.2. Addition involving like terms
   - 1.3. Addition involving mixed numbers with a carry
   - 1.4. Simple Addition of unlike denominators
   - 1.5. Addition involving mixed numbers with unlike denominators and a carry
   - 1.6. Simple subtraction involving unlike denominators
   - 1.7. Subtraction involving mixed numbers--no borrowing
   - 1.8. Subtraction involving mixed numbers and borrowing

2. Complex Fractions

F. Decimals

1. Place Value and Scientific Notation

2. Conversions
   - 2.1. Definition--Decimal to fraction
   - 2.2. Definition--Fraction to decimal
   - 2.3. Conversion--Fraction to decimal
   - 2.4. Conversion--Decimal to fraction

3. Addition and Subtraction
   - 3.1. Addition
   - 3.2. Subtraction

4. Multiplication and Division
   - 4.1. Multiplication
   - 4.2. Division

G. Ratio and Proportion

1. Applications

2. Weights and Measures

H. Percent

1. Conversion
   - 1.1. Conversion of % to decimal
   - 1.2. Conversion of % fraction
   - 1.3. Conversion of decimal to %
   - 1.4. Conversion of fraction to %

2. Formulas and Applications
   - 2.1. A% of B is?
   - 2.2. A is?% of B
   - 2.3. A% of ? is B
   - 2.4. Percent increase and decrease
   - 2.5. Commission
   - 2.6. I=PRT

APPENDIX C-2

DESCRIPTION OF INSTRUCTOR'S GUIDE
BASIC MATHEMATICS (MTH 40)

An instructor's guide to the Basic Mathematics course has been developed and is being supplemented as the course is taught. The following outline describes the content of the guide:

1. Course Outline

2. Copy of Diagnostic Test
   (a) Key
   (b) Answer form

3. Student Record Forms

4. Monday Lectures
   (a) Notes
   (b) Suggestions
   (c) References

5. Student Assignments

6. Study Center Key
   (a) Course Keyed to Study Center Material
   (b) Extra Material for Individual Use

7. Applications
   (Being developed)

8. Topic-Module Tests
   (a) Types of Questions
   (b) Tests
   (c) Key for Tests

9. Final Exam
   (a) Copy
   (b) Key

Additional information about the Basic Mathematics course may be obtained by writing to Ronald L. Waite, Department of Mathematics, Blue Mountain Community College, Pendleton, Oregon 97801

ARITHMETIC | 40 MINUTES

1. Add:

```
  7
  8
  7
  9
  8
 _7_
```

A 47
B 36
C 46
D 48
E none

2. Subtract:

```
 54
-27
```

F 37
G 27
H 36
J 28
K none

Subtract:

```
 90,080
-53,476
```

A 36,614
B 36,504
C 37,514
D 37,604
E none

Multiply:

```
 509
x408
```

F 27,672
G 207,672
H 24,432
J 204,572
K none

Divide: (Indicate if there is a remainder. Example, 7 ÷ 3 = 2 R1)

9) 5,382

A 578
B 575 R7
C 598
D 620 R2
E none

5. Divide:

87) 59,296

F 681 R59
G 680 R36
H 704 R48
J 681 R 49
K none

7. Reduce 1 24/36 to lowest terms:

A 1 1/3
B 1 2/3
C 1 3/2
D 2/3
E none

8. Change 18 2/3 to an improper fraction:

F 56/3
G 58/3
H 46/3
J 39/3
K none

9. Multiply: The answer must be in simplest form:

2/3 of 6/7

A 7/9
B 12/21
C 2/7
D 4/7
E none

10. Multiply:

5 1/2 x 6 x 7/22

F 2 1/3
G 1 10/11
H 3/44
J 10 1/2

11. Divide: The answer must be in simplest form.

2/3 ÷ 3/4

A 1/2
B 8/9
C 1 1/8
D 2
E none

12. Divide: (Same as above)

3 1/2 ÷ 5 1/4

F 3/8
G 1 1/2
H 2/3
J 2/2
K none

13. Add: (to be correct, the answer must be reduced to lowest terms with improper fractions changed to mixed numbers.)

1/6 + 3/6

A 4/6
B 4/3
C 1/3
D 2/3
E none

14. Add: (Same as above)

1/3 + 1/5

F 1/4
G 8/15
H 4/15
J 1 7/8
K none

15. Add: (Same as above)

8 3/4 + 7 7/10

A 16 9/20
B 15 5/7
C 15 9/20
D 16 7/20
E none

16. Subtract: Do not forget the answer must be simplified.

3/4 - 3/8

F 3/4
G 0
H 3/8
J 3/32
K none

17. Subtract: (Same as above)

4 5/6 - 2 7/8

A 1 23/24
B 1 1/6
C 1/8
D 3/8
E none

18. Select the correct value of the missing number:

302/10,000 = ?

F .0302
G .00302
H .0032
J .302
K none

19. Change to a decimal: (Example - 1/16 = .0625 or .06 1/4)

5/8

A 62 1/2
B .625
C 5.8
D 6.25
E none

20. Change to a common fraction in lowest terms:

.025

F 1/40
G 1/20
H 2/5
J 1/4
K none

21. Add:

91.68 + .563 + 1.4

A 23.643
B 28.71
C 22.383
D 2.2643
E none

22. Subtract:

5.86 - 4.982

F .078
G .178
H 7.8
J 4.5618
K none

23. Multiply:

3.27 x .79

A 2,583.3
B 25.833
C .25833
D 2.5833
E none

24. Divide:

1.216 ÷ .04

F 30.4
G 3.08
H 34
J 3.4
K none

25. Change 7.3% to a decimal:

A 7.3
B .73
C .0073
D .073
E none

26. Change each to the equivalent per cent:

23/1,000

F 2.3%
G 230%
H 23%
J .023%
K none

27. Find 16% of 2.4:

A .0384
B 38.4
C 3.84
D .384
E none

28. Find the per cent:

6 is ?% of 15

F 60%
G 6%
H 2 1/2%
J 25%
K none

29. If two owls eat an average of seven mice every four days, how many mice will they devour in a thirty-day month?

A 210
B 105
C 52 1/2
D 15
E none

30. 7 yd. 2 ft. = _____ inches

F 65
G 276
H 252
J 324
K none

APPENDIX C-4

Basic Mathematics Diagnostic Test
(Fall, 1970)

Distribution of Scores

Score	N	CUM%
28	0	.00
27	1	.00
26	1	.01
25	6	.04
24	5	.07
23	2	.08
22	6	.11
21	7	.15
20	15	.23
19	7	.27
18	10	.33
17	8	.37
16	17	.46
15	18	.56
14	11	.62
13	7	.66
12	12	.72
11	9	.77
10	16	.86
9	7	.90
8	9	.95
7	4	.97
6	2	.98
5	1	.98
4	2	.99
3	0	.99
2	0	.99
1	1	1.00

N=184

Mean = 15.1

Median = 15

Item Analysis (Percent of Students Working Each Item Correctly)

Topics	Item No.	% Correct
Whole Numbers (Addition & Subtraction)	1.	.82
	2.	.95
	3.	.71
Whole Numbers (Multiply & Divide)	4.	.78
	5.	.78
	6.	.52
Fractions (Equivalent)	7.	.80
	8.	.53
Fractions (Multiply & Divide)	9.	.45
	10.	.23
	11.	.35
	12.	.24
Fractions (Addition & Subtraction)	13.	.70
	14.	.71
	15.	.54
	16.	.72
Decimals (Conversions)	17.	.35
	18.	.41
	19.	.40
	20.	.40
Decimals (Addition & Subtraction)	21.	.79
	22.	.61
Decimals (Multiply & Divide)	23.	.67
	24.	.52
Percents (Conversions)	25.	.33
	26.	.15
Percents (Formulas)	27.	.40
	28.	.40

Mth 40 - Topic-Module Test E (form a)

Date_____ Name_____

Class Period_____

1. Add: Write answers in simplest form.

   (a) 2/3 + 2/3 (b) 4/9 + 8/9

2. Add: Write answers in simplest form.

   (a) 1/2 + 1/3 (b) 2/9 + 5/12

3. Add: Write answer in simplest form.

   4 1/2 + 1 1/8

4. Add: Write answer in simplest form.

   2 3/5 + 5 2/3

5. Subtract: Write answers in simplest form.

   (a) 4/5 - 1/5 (b) 11/12 - 3/4

6. Subtract : Write answers in simplest form.

   (a) 2 3/5 − 1 2/5 (b) 6 4/5 − 4 3/10

7. Subtract: Write answers in simplest form.

   (a) 7 2/10 − 2 8/10 (b) 8 1/3 − 3 5/6

8. Simplify: $\frac{3/4 + 2/3}{4/5 - 1/2}$

9. A table top is 9/16" thick. The legs on this table are 29 3/8" high. What is the distance from the floor to the top of this table?

10. A board 1 3/4 feet long was sawed off of a 6 1/2 foot board. How long was the piece of board left?

Mth 40 - Topic-Module Test E (form b)

Date_____ Name_____

Class Period_____

1. Add: Write answers in simplest form.

   (a) 1/8 + 5/8 (b) 3/12 + 5/12

2. Add: Write answers in simplest form.

   (a) 3/4 + 5/16 (b) 3/4 + 5/6

3. Add: Write answer in simplest form.

   1 5/8 + 3 1/2

4. Add: Write answer in simplest form.

   8 3/8 + 4 5/6

5. Subtract: Write answers in simplest form.

   (a) 2/3 - 1/3 (b) 9/12 - 1/5

6. Subtract: Write answers in simplest form.

   (a) $\begin{array}{r} 5\ 3/4 \\ -\ 2\ 1/4 \\ \hline \end{array}$ (b) $\begin{array}{r} 13\ 3/5 \\ -\ 6\ 4/5 \\ \hline \end{array}$

7. Subtract: Write answers in simplest form.

   (a) $\begin{array}{r} 2\ 3/8 \\ -\ 1\ 7/8 \\ \hline \end{array}$ (b) $\begin{array}{r} 3\ 3/4 \\ -\ 1\ 9/10 \\ \hline \end{array}$

8. Simplify:

$$\frac{2/3 - 1/9}{3/4 + 1/7}$$

9. Taking a trip from Pittsburgh to Chicago, you pass Cleveland and Toledo. It takes 2 2/3 hours from Pittsburgh to Cleveland, 2 1/6 hours from Cleveland to Toledo, and 4 1/2 hours from Toledo to Chicago. What is the total driving time?

10. 73 1/8 pounds of potatoes are taken from a 100 pound sack. How many pounds are left?

Mth 40 - Topic-Module Test E (form c)

Date_____ Name_____

Section_____

1. Add: Write answers in simplest form.

   (a) 1/10 + 4/10 (b) 5/8 + 1/8

2. Add: Write answers in simplest form.

   (a) 5/8 + 1/12 (b) 3/8 + 1/2

3. Add: Write answer in simplest form.

   3 1/2 + 1 1/4

4. Add: Write answer in simplest form.

   2 7/16 + 1 1/2

5. Subtract: Write answers in simplest form.

   (a) 5/8 - 3/8 (b) 9/10 - 3/4

6. Subtract: Write answers in simplest form.

   (a) 2 7/8 − 1 3/8 (b) 3 1/4 − 1 1/5

7. Subtract: Write answers in simplest form.

   (a) 5 1/4 − 2 3/4 (b) 2 1/4 − 1 1/2

8. Simplify: $\dfrac{1/7 + 3/5}{2/3 - 1/8}$

9. On a pack trip to the Wallowas, Carl walked 5/12 of the distance the first day, 3/8 of the distance the second day. How much of the trip is left?

10. Three Safeway chickens weigh 3 1/2 pounds, 2 3/4 pounds, and 3 1/4 pounds. How much should the last chicken weigh to have 12 pounds of chicken?

Mth 40 - Topic-Module Test F (form a)

Date_____ Name_____

Class Period_____

1. Write the following in expanded notation using exponents.

   (a) 146.8 (b) 0.3476 (c) 156.1077

2. Write in standard scientific notation.

   (a) 1329 (b) .0217

3. Name the following as common fractions in simplest form.

   (a) 0.6 (b) 0.164 (c) 3.375

4. Name each of the following by decimal fractions (correct to the nearest hundredth for "c").

   (a) 5/8 (b) 7/25 (c) 2/3

5. Add:

   4.609 + 3.17 + 14.06

6. Subtract:

   27.06 - 12.367

7. Multiply:

$$\begin{array}{r} 14.86 \\ \times\ 2.93 \\ \hline \end{array}$$

8. Divide: Find quotient to nearest hundredth.

   $6.4\overline{)12.9}$

9. Divide: Find quotient to nearest thousandth.

   $0.86\overline{)7.3042}$

10. Driving to school, Bob puts 7.3 miles on his odometer. How many miles will Bob accumulate driving a five-day week traveling to and from school?

Mth 40 - Topic-Module Test F (form b)

Date_____ Name_____

Class Period_____

1. Write the following in expended notation using exponents.

   (a) 341.12 (b) 146.8792 (c) 3.0617

2. Write in standard scientific notation.

   (a) 325,000 (b) .0349

3. Name the following as common fractions in simplest form.

   (a) 0.8 (b) 0.1134 (c) 7.625

4. Name each of the following by decimal fractions (correct to the nearest hundredth for "c").

   (a) 3/5 (b) 3/16 (c) 5/6

5. Add:

   98.17 + 3.004 + 97.6

6. Subtract:

   397.8 - 9.489

7. Multiply:

$$\begin{array}{r} 39.97 \\ \times\ .427 \\ \hline \end{array}$$

8. Divide: Find quotient to nearest hundredth.

   $7.9\overline{)77.095}$

9. Divide: Find quotient to nearest thousandth.

   $4.6\overline{)0.879}$

10. If it costs $.025 per hour to operate an electric fan, how much will it cost to run it all day?

Mth 40 - Topic-Module Test F (form c)

Date_____ Name_____

Section_____

1. Write the following in expanded notation using exponents.

   (a) 716.829 (b) 71.3046 (c) 0.1214

2. Write in <u>standard</u> scientific notation.

   (a) 68,000 (b) .00293

3. Name the following as common fractions in simplest form.

   (a) 0.3 (b) 0.117 (c) 18.17

4. Name each of the following by decimal fractions (correct to the nearest hundredth for "c").

   (a) 3/4 (b) 18/125 (c) 5/11

5. Add:

   184.09 + 36.104 + 0.14678

6. Subtract:

   71.689 - 3.9429

7. Multiply:

$$\begin{array}{r} 86.84 \\ \underline{\times\ 3.9} \end{array}$$

8. Divide: Find quotient to nearest hundredth.

   $3.94\overline{)0.7968}$

9. Divide: Find quotient to nearest thousandth.

   $9.32\overline{)0.17096}$

10. A ball point pen that sells for $..19 can be purchased for $ 1.49 per dozen. How much do you save <u>per pen</u> if you buy a dozen?

MTH 40
FINAL EXAMINATION

DIRECTIONS: Read each question. Decide which of the answers given below is correct. Record your answers on the answer sheet.

1. The standard numeral for 6×10^7 is

   a. 6.
   b. 6,000,000.
   c. 60,000,000.
   d. 600,000.

2. The place value of the digit 2 in 324,678,153 is

   a. 10^8
   b. 10^7
   c. 10^9
   d. 10^6

3. The value of the digit 7 in 3,765,109 is

   a. 7×10^6
   b. 7×10^5
   c. 7
   d. 70,000

4. A standard numeral for 7,000 + 30 + 6 is

   a. 736
   b. 7,036
   c. 70,036
   d. 7,360

5. The numeral for ten billion is

   a. 10,000
   b. 10,000,000
   c. 10,000,000,000
   d. 10,000

6. 2^5 means

   a. 2×5
   b. $2 \times 2 \times 2 \times 2 \times 2$
   c. $2 \times 2 \times 2 \times 2$
   d. 2

7. In 3^7 the 3 is called

   a. an exponent
   b. the base
   c. a power
   d. a factor

8. In 5^3 the exponent is

   a. 5
   b. 3
   c. 5^3
   d. 125

APPENDIX C-6

MTH 40
FINAL EXAMINATION
COMMENTS

The test contains a total of 100 questions. Additional information on the questions and the test may be obtained from

Ronald L. Waite
Department of Mathematics
Blue Mountain Community College
Pendleton, Oregon 97801

APPENDIX C-8

Basic Math Final Exam
(Fall, 1970)

Distribution of Scores

Score	N	CUM%	Score	N	CUM%
98	1	.01	74	2	.61
96	1	.01	73	5	.64
95	1	.02	72	1	.65
93	1	.03	71	7	.70
92	6	.07	70	2	.71
91	5	.11	69	5	.75
90	1	.11	68	2	.76
89	7	.16	67	3	.79
88	6	.21	66	2	.80
87	8	.26	65	3	.82
86	2	.28	64	4	.85
85	4	.31	62	7	.90
84	7	.36	61	1	.91
83	5	.39	58	2	.92
82	2	.41	57	1	.93
81	8	.46	56	2	.94
80	1	.47	55	1	.95
79	4	.50	54	1	.96
78	1	.51	53	2	.97
77	3	.53	52	1	.98
76	3	.55	51	1	.99
75	6	.59	50	1	.99
			49	1	1.00

N = 140
Mean = 76.57
Median = 79

Basic Math Final Exam
(Fall, 1970)

Item Analysis (Percent of Students working each item correctly)

Item No.	% Correct	Item No.	%Correct	Item No.	%Correct
1	.90	34	.42	67	.95
2	.71	35	.87	68	.80
3	.76	36	.91	69	.86
4	.92	37	.64	70	.88
5	.92	38	.90	71	.81
6	.91	39	.57	72	.50
7	.76	40	.91	73	.57
8	.80	41	.81	74	.85
9	.92	42	.79	75	.77
10	.86	43	.80	76	.64
11	.82	44	.54	77	.74
12	.98	45	.94	78	.98
13	.39	46	.69	79	.68
14	.89	47	.89	80	.93
15	.99	48	.54	81	.90
16	.99	49	.91	82	.74
17	.88	50	.21	83	.84
18	.98	51	.87	84	.57
19	.89	52	.93	85	.93
20	.75	53	.79	86	.89
21	.94	54	.92	87	.60
22	.98	55	.80	88	.59
23	.60	56	.76	89	.97
24	.77	57	.76	90	.34
25	.84	58	.70	91	.79
26	.73	59	.84	92	.45
27	.48	60	.78	93	.67
28	.36	61	.54	94	.68
29	.71	62	.71	95	.94
30	.73	63	.88	96	.57
31	.85	64	.82	97	.71
32	.54	65	.66	98	.55
33	.94	66	.39	99	.58
				100	.81

N = 140

BLUE MOUNTAIN COMMUNITY COLLEGE
DEPARTMENT OF MATHEMATICS
MTH 40 - STUDENT SURVEY
FALL, 1970

1. Did you like the Monday Lecture?

64	Very much
54	All right
0	Of little value
5	Other comments

2. Did you like the weekly tests?

97	Good idea
19	All right
6	Should have done something else
3	Other comments

3. Did you get individual or small group help (if needed)?

87	Whenever needed
24	Sometimes
7	Not enough
21	Other comments

4. Did you have any trouble getting weekly tests in the Math Study Center?

112	Someone available all the time
8	Sometimes no one available
4	Never someone available
1	Other comments

5. What did you think of the chance to repeat tests?

107	Good idea
14	All right
2	Should have done something else
3	Other comments

6. Did repeating tests help you learn?

69	Very much
28	All right
8	Of little value
15	Other comments

7. Did you use any materials in the Math Study Center (other than tests)?

2	Used many
44	Used some
88	Used none
1	Other comments

8. Did you work problems in the text book?

9	All the time
78	Sometimes
27	Never
3	Other comments

9. Did you work the problems or the additional lessor?

36	All the time
82	Sometimes
6	Never
1	Other comments

10. Did you attend Monday lectures?

95	All of them
29	7-10 of them
3	3-6 of them
0	Less than 3

11. Did you think this course was a good way to learn Mathematics?

108	Very good way
24	All right
1	Should have done something else
1	Other comments

A summary of the "other comments" is on the following page.

APPENDIX C-8

Student Comments
Basic Mathematics
Fall, 1970

I don't think I could have learned this much any other way.

Not too good in Math although I didn't get all, it helped me quite a bit.

The availability and help from teacher(s) was of great help.

I can not see where you could improve anything.

This math class was different from any I have been in, more time should be spent with students. Some students wanted to pass the test so they could get out of class for the rest of the week. You did a great job, I learned a lot. You showed me some things I had never seen before.

This is the best idea for math I have ever seen.

Best course in math I have ever had.

Course well planned, well presented, learned a lot.

No weakness, good way to teach, give student fair chance, easy way to learn.

Monday lecture helpful, test each week good learning.

All subjects were covered and I need them but still don't understand fractions.

Class was left up to the individual which was good. Some people did not take advantage of this.

Thought it was good way, should have spent more time on harder areas.

Lecture and weekly tests best way to learn, extra help anytime was rewarding.

Enjoyed the class, couldn't have been any better.

Course of great help (I have been out of school 10 years).

I believe the program, as is, covers the course completly.

A new and better way of teaching math.

DESCRIPTION OF COURSE CONTENT

ELEMENTARY ALGEBRA (Math 45)

There are four major topic-modules in the course. They are

A. Sets, Variables, and Sentences
B. Integers, Rational Numbers, and Real Numbers
C. Fractional Expressions and Polynomials
D. Solving Sentences

The specific content (topic-units) is described in this appendix.

A. Sets, Variables, and Sentences

1. Sets and Whole Numbers
2. Numerals and Binary Operations
3. Numeral Expressions and Order of Operations
4. Variables and Variable Expressions
5. Introduction to Equations
6. Properties of Whole Numbers: Part One
7. Properties of Whole Numbers: Part Two
8. Whole Numbers Used as Exponents

B. Integers, Rational Numbers, and Real Numbers

1. The Set of Integers
2. Addition and Subtraction of Integers
3. Multiplication and Division of Integers
4. Simplifying Numeral Expressions Containing Integers
5. Simplifying Variable Expressions
6. The Fractional Form and Meaning of Rational Number
7. The Set of Real Numbers

C. Fractional Expressions and Polynomials

1. Basic Properties of Fractional Expressions
2. Multiplication and Division of Fractional Expressions
3. Addition and Subtraction of Fractional Expressions
4. Multiplication of Algebraic Expressions
5. Factoring Algebraic Expressions
6. Operations with Fractional Expressions

D. Solving Sentences

1. Solving Equations - First Degree and Quadratic
2. Solving Equations - Fractional and Absolute Value
3. Problem Solving

APPENDIX D-2

DESCRIPTION OF INSTRUCTOR'S GUIDE ELEMENTARY ALGEBRA (MTH 45)

An instructor's guide to the Elementary Algebra course has been developed and is being supplemented as the course is taught. The following outline describes the content of the guide:

1. Introduction
2. Schedules
3. Weekly Report Forms
4. Key to Study Center Materials
5. Suggestions of Classroom Activity
6. Errata Sheet
7. Student Record Forms
8. Topic-Unit Redirect Sheets
9. Topic-Unit Tests
   (a) Copies
   (b) Key
10. Applications
11. Topic-Module Tests and Finals
    (a) Copies
    (b) Answer Sheets for Mid-terms
    (c) Key

Additional information about the Elementary Algebra course may be obtained by writing to:

Ronald L. Waite
Department of Mathematics
Blue Mountain Community College
Pendleton, Oregon 97801

Edward Wright
Department of Mathematics
Linn-Benton Community College
Albany, Oregon 97321

BLUE MOUNTAIN COMMUNITY COLLEGE
DEPARTMENT OF MATHEMATICS

TO: Elementary Algebra Students

The purpose of this course is to help you understand the basic principles of algebra and to teach you how to apply these principles to solving problems that are difficult or impossible to solve by arithmetic.

The course will be presented in a way that is different from what you are accustomed to finding in a conventional course. The audio-tutorial method of studying mathematics will be used as follows:

LAB For two hours per week, on the average, you go to the Library with your book, pencil, and paper; check out a tape; proceed to a study carrel; and study a unit. When you feel you have mastered the basic concepts of the unit, you request a unit test from the Math Study Center.

CLASS You spend two hours a week in discussion classes devoted to answering student questions and solving problems introduced by teacher-made worksheets.

OTHER Your teacher will be available in your classroom on Fridays for small group recitations and in his office during office hours for individual assistance. In addition the Math Study Center personnel are available at all hours.

These techniques were chosen for the following reasons:

1. Since the lecture and other explanations are put on audio tape and the chalkboard illustrations are put in the text, you have a permanent record of the material generally presented in class.

2. You may go through the lecture at your own rate and any part of the lecture may be reviewed as often as desired by simply reversing the tape player and turning back in the text.

3. Since the lecture and most of the quizzes have been removed from the classroom, class time may be used to review key concepts and to develop your ability to read and understand mathematical statements and your ability to translate into mathematical language statements and problems expressed in ordinary English.

4. There is ample opportunity for each of you to meet with your teacher for individual instruction.

When you have finished this course, you should be acquainted with the basic methods of algebra and how it relates to arithmetic. You should be familiar with the general theory, use, and handling of simple equations.

APPENDIX D-3

Department of Mathematics
Blue Mountain Community College

SCHEDULE

Mth 45 - Elementary Algebra
Winter - 1971

Your CLASS sessions will be held on Monday and Wednesday in your assigned classroom. Your LAB assignments are outlined below. The Math Study Center is where you take your unit quizzes and turn in your supplementary problems, worksheets, and weekly reports. The Mid-term tests will be administered in the classroom on the indicated days.

January 4-January 8	Week One	Pre-test, Unit 1, Unit 2
January 11-January 15	Week Two	Unit 3, Unit 4, Unit 5
January 18-January 22	Week Three	Unit 6, Unit 7, Unit 8 (Worksheet A is due on Friday)
January 25-January 29	Week Four	Unit 9, Unit 10 (Mid-term A (units 1-8) on Monday)
February 1-February 5	Week Five	Unit 11, Unit 12, Unit 13 (Worksheet B is due on Friday)
February 8-February 12	Week Six	Unit 14, Unit 15
February 15-February 19	Week Seven	Unit 16, Unit 17 (Midterm B (units 9-15) on Monday)
February 22-February 26	Week Eight	Unit 18, Unit 20 (Worksheet C is due on Friday)
March 1-March 5	Week Nine	Unit 21, Unit 22 (Mid-term C (units 16-18, 20-22) on Wednesday)
March 8-March 12	Week Ten	Unit 23, Unit 24 (Worksheet D is due on Friday)
March 15-March 18	Final Week	Post-Test

* * *

"We educate ourselves" is a time-worn but true statement. Books, materials, teachers and other people, all can help us; but we must do the studying. Why did you learn to write your name correctly? Because you wanted to. With this course you can improve your basic skills in Math if you want to. The degree of success you have will be directly related to the degree of effort you put into your studies. The text and related materials and your teacher can help you, but you must study.

MTH 45 - ELEMENTARY ALGEBRA
TOPIC-UNIT TEST - A5

1. $6 = 20 - 14$ is _____.
   a. A false equation.
   b. A true equation.
   c. An open equation.
   d. Is not an equation.

2. $8 = 2 + 5$ is _____.
   a. A false equation.
   b. A true equation.
   c. An open equation.
   d. Is not an equation.

3. $x = 1$ is _____.
   a. A false equation.
   b. A true equation.
   c. An open equation.
   d. Is not an equation.

4. $Y = 8 \div 0$ is _____.
   a. A false equation.
   b. A true equation.
   c. An open equation.
   d. Is not an equation.

5. $= 4$ is _____.
   a. A false equation.
   b. A true equation.
   c. An open equation.
   d. Is not an equation.

6. $(5) = (x) + (3)(y) = x + 2$
   a. A false equation.
   b. A true equation.
   c. An open equation.
   d. Is not an equation.

7. $a = 0 - 0$ is _____.
   a. A false equation.
   b. A true equation.
   c. An open equation.
   d. Is not an equation.

8. $(3)(x) = (3)(x)$ is _____.
   a. A false equation.
   b. A true equation.
   c. An open equation.
   d. Is not an equation.

Mark A. if the given equation is ture. Mark B. if the given equation is false. Mark C. if the given equation is open.

9. $1 + 3 = 5$
10. $3 \cdot x = 8$
11. $x = 2$
12. $x \div 3 = x + 3$
13. $x + 1 = x$

Mark T if 5 is a root of the given equation. Mark F if it is not a root of the given equation.

14. $(2)(x) = 10.$
15. $x = 5$
16. $(2)(x) - 10 = 0$
17. $(x)(x) = 25$
18. $(5)(a-a) = 0$
19. $(5)(a) - a = 0$
20. $7-x = 10 \div x$

Pick the solution to each of the following equations from among the sets given.

21. $3 \cdot x = 45$
    a. $\{135\}$
    b. {whole numbers}
    c. {natural numbers}
    d. $\{15\}$
    e. None of these

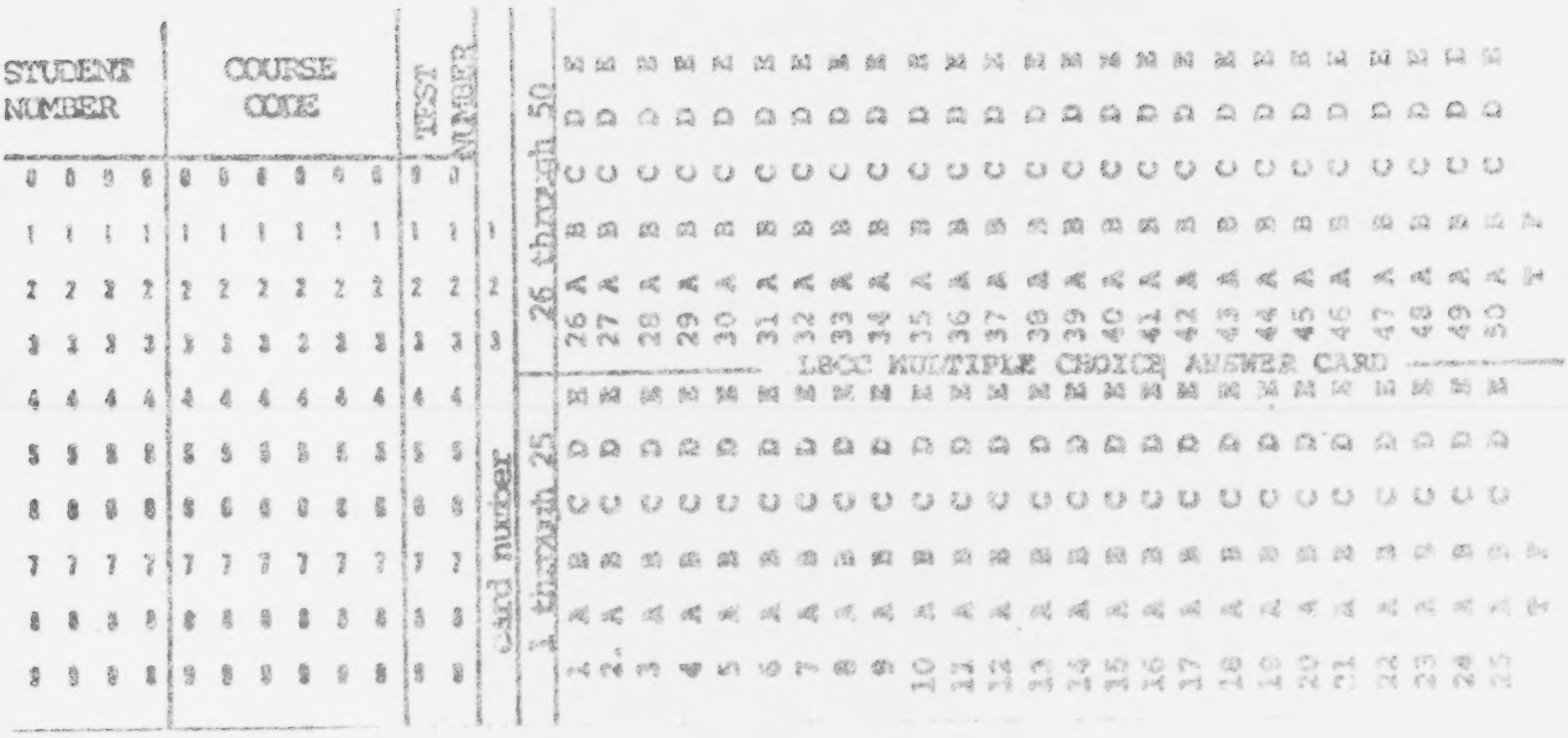
22. $Y = y$
    a. $\{1\}$
    b. {natural numbers}
    c. {whole numbers}
    d. $\emptyset$
    e. None of these

23. $4 \cdot a + a = 10$
    a. $\emptyset$
    b. $\{2\}$
    c. {natural numbers}
    d. $\{0\}$
    e. None of these

24. $Y \cdot Y = 16$
    a. $\emptyset$
    b. $\{2\}$
    c. {natural numbers}
    d. {whole numbers}
    e. None of these

Specify the fundamental property of equations which justifies each of the following statements by marking the appropriate letter. reflexive - A., symmetric - B, substitution - C, addition - d, multiplication - E.

25. If $2x = 6$, then $6 = 2x$
26. $10 = 10$
27. If $k = 4$, then $3k = 3 \cdot 4$
28. If $t = 0$, then $t + 5 = 0 + 5$
29. If $t = x$, then $3t + 4$ may be written as $3x + 4$
30. If $x = a$ and $y = a$, then $x = y$



UNIT REDIRECT SHEET

UNIT NINE

Mth 45

Name_____ Score_____

Problem Number		Frames to Review	
I.	XII.	3, 7, 27	21, 23
II.		19	
III.		23	
IV.	(1)		
	(2)		
	(3)	4	
	(4)		
	(5)	15	
	(6)	8	
	(7)	27	
V.		27	
VI.		5	
VII.		10-12	
VIII.	(1)		
	(2)		
	(3)	29-32	
	(4)		
	(5)		
IX.	(1)		
	(2)		
	(3)	38-41	
	(4)		
	(5)	44	
X.		17	
XI.	(1)		(7)
	(2)		(6)
	(3)		(5)
	(4)	45	
	(5)		(6)
	(6)		(1)
	(7)		(2)
	(8(		(3)

APPENDIX D-5

Mth 45 - Student Survey

	much less	less	same	more	much more
1. At the beginning of the quarter, how well did you like mathematics as compared with other academic subjects such as English, chemistry and history?	17%	23%	37%	17%	6%
2. How well do you like mathematics now as compared with other academic subjects such as English, Chemistry and history?	7	17	40	23	13
3. At the beginning of the quarter how much fear did you have of mathematics as compared with other academic subjects such as English, chemistry and history	13	10	30	37	10
4. How much fear do you now have of mathematics compared with other academic subjects such as English, chemistry and history?	27	13	29	27	4
5. At the present time how willing are you to take another course in mathematics, taught conventionally, as compared with other academic courses?	27	14	10	27	22
6. At the present time how willing are you to take another course in mathematics taught with the audio tutorial method compared to other academic courses?	43	6	6	13	32
7. At the present time how much does concern about grades affect your attitude toward taking mathematics as compared with other academic courses?	6	17	27	30	20

		large detrimental effect	small detrimental effect	no effect	small beneficial effect	large beneficial effect
8.	I could repeat any section of a taped lesson as often as necessary by pushing a lever . . .	6	13	17	40	24
9.	The Audio-Tutorial Laboratory was open for many hours a day so I could study a lesson at my own convenience at any time. .	0	0	3	23	74
		much less	less	same	more	much more
10.	Rate how interesting the A-T taped lesson tended to be in comparison with standard classroom mathematics presentations.	53	7	27	13	0
		very unpleasant	unpleasant	average	pleasant	very pleasant
11.	Rate the pleasantness of the voices on the A-T taped lessons.	40	6	24	16	0
		much too slow	little too slow	just right	little too fast	much too fast
12.	How fast were the taped voices for you?	7	14	67	9	3

A summary of the general comments is on the following page.

Student Comments
Elementary Algebra
Fall, 1970

Great Course - only way to learn Algebra - However I think we had to go to fast through last units.

I learned more than I thought I could when I began.

The material was well presented, but not enough time on word problems.

Why don't we have a programmed course for Intermediate Algebra these were very good.

Good course, I enjoyed it besides learning so much.

I have listened to the tapes that were not assigned and why didn't we do quadratic equations, they are fun.

I can do the problems of solving equations but still have some trouble setting up the word problems.

This has been the first good class in mathematics, now I want to go on and take another course.

The factoring section seemed very easy to understand and I now believe that I will be able to handle fractions.

The word problems that are used for the examples are very good but you helped the most with the class discussions.

The best way to teach the idea of sets and operations that I have seen, I didn't understand the idea before but now it is quite clear.

I didn't understand the properties until you explained them in class. The explanation was very good and now I know them even if they don't have too much importance to me now.

Very good way to teach exponents, they explained them very well on the tapes.

Fractions can be fun, at least after playing the tape three times I can do most of them.

The first time I was able to understand why we can do things with equations. The properties of the integers certainly help.

Now I can see a use for word problems.

DESCRIPTION OF COURSE CONTENT

INTERMEDIATE ALGEBRA (Mth 95)

There are six major topic-modules in the course. They are

A. Real Number System
B. Linear Equations and Inequalities
C. Polynomials
D. Fractional Expressions
E. Exponents, Roots, and Radicals
F. Quadratic Equations

The specific content (topic-units) is described in this appendix

A. Real Number System

1. Real Number Subsets
2. Union, Intersection, and Subset Concepts
3. Inequalities
4. Set Builder Notation
5. Field Axions for Real Numbers
6. Absolute Value
7. Order of operations

B. Linear Equations and Inequalities

1. Solving Linear Equations
2. Literal Equations and Identities
3. Solving Linear Inequalities and Graphing the Solution Set
4. Solving Equations of the Form $|ax + b| = c$
5. Solving Inequalities of Forms Similar to $|ax + b| < c$ and Graphing this Solution Set
6. Graphing Linear Equations and Linear Equations With Absolute Values by Plotting Points
7. Solving Systems of Linear Equations with Two Unknowns
8. Solving Systems of Linear Equations with Three Unknowns
9. Graphing Inequalities and Systems of Inequalities in Two Unknowns

C. Polynomials

1. Adding and Subtracting Polynomials; Eliminating Parenthesis
2. Evaluating Polynomials; Products of Polynomials
3. Factoring Polynomials
4. Advanced Factoring of Polynomials

D. Fractional Expressions

1. Simplifying Fractions
2. Synthetic Division
3. Adding and Subtracting Fractional Expressions
4. Multiplication and Division of Fractional Expressions

E. Exponents, Roots, and Radicals

1. The Meaning of Exponential Notation; Simplifying Expressions: The Relation Between Radical and Exponential Notation
2. Simplifying Radical Expressions

F. Quadratic Equations

1. Solving Quadratic Equations by Factoring
2. Solving Quadratic Equations by Completing the Square
3. Solving Quadratic Equations by the Quadratic Formula
4. Solving Equations Containing Radicals and Equations in Quadratic Form
5. Solving Quadratic Inequalities and Graphing Their Solution Sets

DESCRIPTION OF INSTRUCTOR'S GUIDE INTERMEDIATE ALGEBRA (MTH 95)

An instructor's guide to the Intermediate Algebra course has been developed and is being supplemented as the course is taught. The following outline describes the content of the guide:

1. Explanation of procedures
2. Course Outline
3. Time Schedule
4. Sample Student Information Sheet
5. Suggested Problem Assignment Schedules
6. Masters for Topic-Unit Tests
7. Samples of Topic-Module Test I
8. Samples of Topic-Module Test II
9. Samples of Topic-Module Test III
10. Sample Final Exam
11. Commentary on Each Topic-Unit

Additional information about the Intermediate Algebra course may be obtained by writing to Mickey McClendon, Department of Mathematics, Blue Mountain Community College, Pendleton, Oregon 97801

REFERRAL FORMS
MTH 95

MTH 95

NAME George Peck DATE 6-1-71

SECTION A INSTRUCTOR McClendon

QUIZ RESULTS: Retake test F-2

ASSIGNMENT: No assignment, but check your work more carefully.

DATE DUE 6-3-71

DATE COMPLETED

MTH 95

NAME Ewert Kyle DATE 6-1-71

SECTION A INSTRUCTOR McClendon

QUIZ RESULTS: Retake test F-2

ASSIGNMENT:

DATE DUE 6-4-71

DATE COMPLETED

Reference 54, unit 10.
Complete the study exercises on page 131 before retaking the test.

TOPIC-UNIT TESTS
MTH 95

Math 95
Topic-Unit Test F2, Form A

NAME_____

Solve the following quadratic equation by completing the square:

$$(2x - 3)^2 = x + 14$$

Math 95
Topic-Unit Test F2, Form B

NAME_____

Solve the following quadratic equations by completing the square:

$$8x - 3 = 2x^2$$

Mth 95
Topic-Unit Test F2, Form C

NAME_____

Solve the following quadratic equation by completing the square.

$$(x - 1)^2 = 2x + 1$$

MTH 95 - Student Survey
Fall, 1970

DIRECTIONS: We are attempting to get information from you, the student, regarding the procedures and materials that have been used in the course in which you have been enrolled this term. This is not to be an evaluation of the instructor(s). Read each question and its answers. When you have decided which one best expresses your feelings, place a cross (x) or a check (✓) in the blank in front of the statement or phrase which best describes your reaction.

1. Approximately how many times did you see your math instructor for a conference during the term for a conference on course material?

   18 Never
   39 1-4 times
   8 More than 4

2. Do you believe that the procedures currently used in your class encouraged you to go to your instructor for assistance more often, less often or about the same as a regular class?

   29 More often
   5 Less often
   31 About the same

3. What do you think of the short quizes?

   52 Good idea
   11 All right
   2 Should have done something else

4. What do you think of the chance to repeat quizes?

   57 Good idea
   5 All right
   3 Should have done something else

5. Did you have any trouble getting help in the Math Study Center?

   38 Someone available all of the time
   13 Sometimes no one available
   1 Often had trouble getting help
   11 I never needed help

6. Did you use any materials in the Math Study Center?

   12 Used many
   41 Used some
   15 Used none

A summary of the general comments is on the following page.

Student Comments
Intermediate Algebra
Fall, 1970

The teacher was good and I was taught more than ever before.

Being able to take the quzes over and to use the material in the study center was a great help.

Don't change anything about the class. I like it.

I liked it because we were able to work together in groups and at the board.

If one availa himself to the opportunities there is a great chance for educational uplift.

What I liked most was the concern for the individual.

It's not stuffy - it's a lot of fun.

I appreciated the chance to make up quizes. You finally do get the material through the use of repeat quizes.

It's a good way to learn.

Personalized instruction was the strong point.

It was an informal, easy - going class.

The class was very friendly and sometimes learning math was actually fun!

I feel this was the best class in math I have ever taken. I learned more during this term than in all 4 years in high school math.

The help I got was really great.

The short quizes show readily where more work is needed. Also the instructor encouraged students to come in for more help.

I like the class. Leave it like it is.

This is the first time math has given one a sense of accomplishment.

The study center is a good place to get assistance.

APPENDIX F

STUDY CENTER INFORMATION

A Study Center Manual has been prepared to explain what the Study Center is and how it can be used in the teaching of mathematics at Blue Mountain Community College. The goal of the manual is to expediate the user's selection of Center materials. The manual contains an Index to the materials that are available in the Center. The teacher uses the Index to identify materials that will help individual students with particular topical deficiencies. These materials have been reviewed, cataloged, and indexed for easy reference to the mathematics topics taught at BMCC. These materials have been cataloged as follows:

1-19:	Arithmetic Materials
20-39:	Elementary Algebra Materials
40-59:	Intermediate Algebra Materials
60-69:	College Algebra Materials
70-79:	Trigonometry and Analytic Geometry Materials
80-89:	Calculus Materials
90-99:	Statistics Materials, Computer Materials
100-119:	Arithmetic Materials
120-139:	Elementary Algebra Materials
140-159:	Intermediate Algebra Materials
160-169:	College Algebra Materials
170-179:	Trigonometry and Analytic Geometry Materials
180-189:	Calculus Materials
190-199:	Statistics Materials, Computer Materials
200-232:	Teinac Program Materials
300-359:	SRA Mathtapes Program Materials
360:	SRA Computational Skills Development Kit
370:	SRA Algebra Skills Kit
400-420:	MAST Program Materials
500-515:	TUTORFILM Program Materials
601-634:	Elementary Algebra Audio Tape Materials
701-729:	Intermediate Algebra Audio Tape Materials
801-854:	PRACTICE TAPES, ALGEBRA I
900:	Miscellaneous Materials
901-904:	SLIDE RULE

The Index contains references to the best material available for studying each of the topics in each course. For example, the following page contains a copy of part of the Mth 95 (Intermediate Algebra) section of the Index.

95F QUADRATIC EQUATIONS

95F 1. Solving Quadratic Equations by Factoring

53 Moon and Davis, Unit 23
54 Newmyer and Klentos, Unit 10
44 Ashley and Harvey, Pages 265-269
42 Reigh and Hauck, Pages 444-452, Frames 20-42
41 Alwin and Hackworth, Book 2, Pages 297-314, Frames 299-self quiz #7
47 Cooley and Mansfield, Volume II, Lesson 51, Pages 381-388
50 Flexer and Flexer, Book 3

95F 2 Solving Quadratic Equations by Completing the Square

53 Moon and Davis, Appendix I
54 Newmyer and Klentos, Unit 10
44 Ashley and Harvey, Chapter 7, Pages 277-282
42 Reigh and Hauck, Pages 434-441 and Pages 455-469
41 Alwin and Hackworth, Book 2, Pages 386-436, Frames 490-804
47 Cooley and Mansfield, Volume II, Lesson 52, Pages 389-395

The teacher finds the topic, e.g. - solving quadratic equation by completing the square, in the Index and selects the best assignment, e.g. - 54 Newmyer and Klentos, Unit 10. The student then may proceed with the assignment at his own pace and his own convenience.

The manual also contains a Test File and an explanation of the procedures involved in handling the Independent Study Program.

APPENDIX G

BIBLIOGRAPHY OF RESEARCH MATERIALS

This is a listing of materials from educational research projects which dealt with developmental and occupational mathematics.

1. Alkins, Marvin C. and others,
   Instructional Objectives Exchange.

2. Boggs, John R.,
   A Developmental Research Plan for Junior College Remedial Education (1968)

3. Boggs, John R.,
   A Developmental Research Plan for Junior College Remedial Education, Number 3 (1969).

4. Chinn, William G. and Summerfield, Jeanette O.,
   SMSG Reports No. 4 (1967)

5. Collins, Charles C.,
   Financing Higher Education: A Proposal (1970).

6. Conner, Aikin,
   Is it Really a Better Technique? (1969)

7. Davis, Klinger, Lovelace, and Young,
   "Individualized Mathematics Program" materials

8. De Venney, William S.,
   SMSG Reports No. 6 (1968)

9. Encyclopedia Britannica Education Corportation,
   Math Learning Center I, (1968)

10. Herriot, Sarah T.,
    SMSG Reports No. 5 (1967)

11. Howlett, John L.,
    "A study of placement methods for entering college freshman in the paper mathematics sequence at Michigan Technological University",
    The Mathematics Teacher, December 1969

12. Individual Learning Systems Inc. ILS Instructional Materials.

13. Leiderman, Gloria F., William G. Chinn, Mervyn E. Dunkley,
    SMSG Reports No. 2 (1968)

14. Leppke, Don,
Information on a laboratory approach for teaching mathematics to low achievers for junior high and senior high school students at Canby, Minnesota.

15. Lial, Margaret L.,
"Programmed Instruction in Elementary Algebra",
The Two Year College Mathematics Journal, Fall, 1970.

16. Lieberman, J.,
Levittown Study Materials, Levittown, N.Y.

17. May, Kenneth O.,
Programmed Learning and Mathematical Education,
George Banta Company, Inc. (1965).

18. Morgan, William P.,
"Prediction of success in junior college mathematics,"
The Mathematics Teacher, March 1970.

19. Motivational Development Inc.,
"Success in Mathematics" materials.

20. Muskegon Public Schools,
Frontiers of Change (1969).

21. Muskegon Public Schools,
"A study of the improvement of mathematics instruction for the educationally disadvantaged student in the secondary school? (1967).

22. NCTM,
Research in Mathematics Education (1967).

23. O'Connor, Edward F., Jr.,
Identifying the Effective Instructor (1970).

24. Palm Beach County Schools, Palm Beach, Florida,
Project Mathematics (1968).

25. Rosenbloom, Dr. Paul C., Director,
CAMP (Concepts and Applications of Mathematics Project),
Project conference report (1966).

26. Shoemaker, Terry E.,
Colamda (Committee on low achievers in Mathematics-Denver Area)
Materials

27. Shoemaker, Terry E.,
Involving Low-achievers in Mathematics (1965).

APPENDIX H

BIBLIOGRAPHY OF SOURCE MATERIALS

These books contain good examples of how mathematics is used in the various occupations.

1. Denholm, Dolciani, Cunningham,
   Elementary Algebra-Part I,
   Houghton Mifflin Company, 1970

2. Denholm, Dolciani,
   Elementary Algebra-Part II,
   Houghton Mifflin Company, 1970

3. Dolciaci, Berman and Freilich,
   Modern Algebra--Structure and Method,
   Houghton Mifflin Company, 1962

4. Douglis, Avron,
   Ideas in Mathematics,
   Delmar Publishing, Inc., 1953

5. Gold, Marvin and Carlberg, Robert E.,
   Modern Applied Mathematics,
   Houghton Mifflin Company 1971.

6. Henderson, Kenneth B. and Pingry, Robert E.,
   Using Mathematics,
   McGraw-Hill, Inc., 1969.

7. Lay, L. Clark,
   From Arithmetic to Algebra,
   Macmillian, 1970.

8. Nielsen, Kaj L.,
   Mathematics for Practical Use,
   Barnes and Noble, Inc., 1962.

9. Olivo, C. Thomas,
   Basic Mathematics Simplified,
   Delmar Publishing, Inc. 1953.

10. Rizer, Conrad,
    Police Mathematics,
    Charles C. Thomas-Publisher, 1955.

11. Stein, Edwin L.,
    Fundamentals of Mathematics,
    Allyn and Bacon, Inc., 1968.